TO EVALUATE THE DIAGNOSTIC EFFICACY OF CORNEAL EPITHELIAL THICKNESS USING SPECTRAL DOMAIN OPTICAL COHERENCE TOMOGRAPHY (SDOCT) IN KERATOCONUS

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DEDICATED TO MY

GRANDFATHER

LT. CAPTAIN. GURBACHAN

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ABBREVIATIONS

KCN	:	Keratoconus
FFKCN	:	Form Fruste Keratoconus
ART	:	Ambrosio Relational Thickness
D value	:	Deviation From Mean
FET	:	Front Elevation Thickness
BET	:	Back Elevation Thickness
SN-IT	:	Superonasal Inferotemporal Asymmetry
I-S	:	Inferior Superior Asymmetry
Min-median	:	Minimum Epithial Thickness- Median Epithial Thickness
Min	:	Minimum Epithelial Thickenss
Central-minimum	:	Central - Minimum Epithelial Thickness
ROC	:	Receiver operating characteristic curve
AUC	:	Are under curve
ANOVA	:	Analysis of variance

ABSTRACT

Introduction: Keratoconus is non inflammatory disease characterised by progressive corneal thinning and apical protusion. Its most common primary ectasia, estimated prevalence in general population is 54 per 100000. It is asymmetric and bilateral in 90% patients. Corneal topography (pentacam) has been the main investigation for its diagnosis, but recently corneal tomography(ASOCT) has been under research for epithelial mapping of corneal for early diagnosis, management and prevention of compications of keratoconus

Aim of Study: To evaluate the usefulness of corneal epithelial thickness profile using spectral domain optical coherence tomography (SDOCT) in keratoconus.

Material and Methods: It was a cross sectional observational study. Eyes with keratoconus, forme fruste keratoconus and normal corneas were assessed clinically, using pentacam and SDOCT. Various parameters of epithelial maps were evaluated and compared between 3 groups.

Results: Study involved 208 eyes of 104 patients in study group which was further divided into keratoconus and form fruste keratoconus, 112 eyes of 56 patients were taken as control. Minimum, Central, min-median, SN-IT, I-S, Central-minimum epithelial mean were 33.99 ± 4.27µm, 46.78±8.54 µm, -16.93 ± 47.14 µm, 4.98±7.21 µm, 1.87±6.67 µm respectively for KCN group. Compared with normal controls p value was significant (<0.05) in central, min-median, SN-IT and I-S. AUC in KCN was 0.532, 0.826, 0.783, 0.725, 0.701, 0.682 for minimum, min-median, SN-IT, central, I-S, central-minimum except minimum epithelial thickness all other were statistically significant (p<0.05).

Conclusion: Epithelial corneal mapping with ASOCT in keratoconus patients might be helpful in early diagnosis of keratoconus**.**

Keywords: Keratoconus, ASOCT, Pentacam

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INTRODUCTION

Corneal epithelium covers the surface of cornea, where it protects the eye and plays an important role in maintaining high optical quality.[1] Keratoconus was first described in 1854, derived from greek words kerato (cornea) and konus (cone). It is a non inflammatory disease characterized by progressive corneal thinning and apical protrusion. It is the most common primary ectasia with estimated prevalence of population is 54 per 100000.[2]

The prevalence ranges from 0.3/100,000 in Russia to 0.3 to 2300/100,000 (0.0003–2.3%) in Central India.[3] In Middle East & Asia including India, keratoconus presents at a younger age and progresses more rapidly.[4] Family history of keratoconus has been found to be variable, ranging from 6% to 21.74%.[1]

Keratoconus was thought to affect approximately 1 person in 2000 according to a 48 year old study conducted in US, with a mean incidence of 2 new cases per 100,000 per year [5] but Godefrooij and colleagues [6] conducted an epidemiological study in 4.4 million patients that showed annual incidence of 1:7500 (13.3 cases per 100,000) and the estimated prevalence of 1:375 (265 cases per 100,000) in Netherland.

It is asymmetric and bilateral in 90% patients. Patients typically present in the second decade of life, youngest diagnosed case is of 4 years old female.[7]

Thinning and ectasia process usually starts prior to presentation and continues over a period of 1 to 2 decades until the progression gradually halts. Progression rate is variable ranging from very mild irregular astigmatism to severe thinning, protrusion, and scarring.

Corneal thinning occurs normally in the inferior-temporal as well as central cornea.[2] corneal protrusion causes high myopia and irregular astigmatism, affecting the visual quality. It usually become apparent

during second decade of life (normally during puberty) and typically progresses until the fourth decade of life after which it usually stabilizes.[2]

EITIOLOGY: Children and adolescents are at a greater risk of disease related complications. Keratoconus tends to be more progressive (88% of KC [8] eyes) and more severe at diagnosis with 27.8% being stage 4 as compared to 7.8% of adults ($P < .0001$).[9] Eye rubbing has been identified as an etiologic factor in the development of keratoconus.[10-12]

In DUSKS study [13] of 200 keratoconus patients, it was an observational study from 1997 to 2000. Only 11% of patients reported never rubbing their eyes and 48% reported frequent eye rubbing.

Bawzeer et al.[14] found that atopy, eye rubbing and family historyof keratoconus were all associated with the development of keratoconus.

Rubbing causes microtrauma to cornea. Vigorous eye rubbing has frequently been observed in conditions like vernal keratoconjunctivitis, atopic disease, Down syndrome Leber tapetoretinal degeneration and retinopathy of prematurity and thus their association with keratoconus can be hypothesized

Contact lens wear also exposes cornea to microtrauma. Keratoconus was 17.5% [15] before contact lens wear and 26.5% [16] afterwards

Biochemistry:

The total amount of protein is decreased in keratoconus.[17]

There is up-regulation of degradative enzymes and the down-regulation of proteinase inhibitors, this result in a degradation of the extracellular matrix of the stroma. Degradative lysosomal enzymes, such as acid esterase and acid phosphatase, cathepsins B and G, and some matrix metalloproteinases, has been shown to be elevated in keratoconus corneas.[18,19] but if these mechanisms were solely responsible for keratoconus then it shoud have recurred after corneal transplant in donor cornea, which is not the case.

Keratoconus corneas have been found to have 4 times more Interleukin-1, which has shown to induce apoptosis in vitro. Wilson et al.[20] response to microtrauma occurring after eye rubbing or contact lens wear. This in turn could trigger apoptosis of stromal keratocytes in keratoconus patients with a heightened sensitivity to interleukin-1.

Heredity: There are reports of at least 18 sets of monozygotic twins that identify one or both siblings in the pair with evidence of keratoconus McMahon et al.[21] described two pairs of discordant monozygotic twins, in which one of each pair had keratoconus and the other had normal corneal topography in both eyes. It was suggested that an environmental trigger might be necessary in addition to a genetic predisposition or that genetic differences between the individuals may exist, even inmonozygotic twins. A “two-hit” hypothesis, i.e. genetic predisposition plus environmental insult, such as eye rubbing, is a leading theory on the development of keratoconus.[22]

Keratoconus has been found in association with chromosomal abnormalities other than and with Down syndrome, it is also associated with a chromosome 7, 11 translocation[23] chromosome 13-ring abnormality.[24] Wang et al.[25] found the keratoconus prevalence of first-degree relatives to be 3.34%, which is up to 68 times that found in the general population

Pathology :

Keratoconus can involve any layer and tissue of the cornea. Specular microscopy of the corneal epithelium has revealed enlargement of the superficial cells and prominence of elongated cells, specifically over the apex of the cone. Early degeneration of the basal epithelial cells can be followed by disruption of the epithelial basement membrane. Due to Breaks in the epithelial layer can be associated with epithelium grows posteriorly into Bowman's layer and collagen growing anteriorly into the epithelium, forming Z-shaped interruptions at the level of Bowman's layer.[26] These Z-shaped areas are typical of keratoconus.

Fleischer ring is hallmark of keratoconusand is found at the base of the cone Light and electron microscopy reveal that ferritin particles accumulate within and between the epithelial cells, particularly in the basal epithelium.[27]

Shapiro et al.[28] correlated anterior clear spaces detected clinically within the thinned stroma of the cone with interruptions of Bowman's layer. They postulated that these breaks in Bowman's layer may later fill with scar tissue.

Clinical presentation:

Severity of Disease vary the ocular symptoms and signs of keratoconus. At early stages there are hardly any symptoms and can often go unnoticed by the patient and practitioner itself, its termed as subclinical or frustre forms and require specific tests (i.e., corneal topography) for diagnosis.[29] Initial manifestation usually is significant loss of visual acuity which cannot be compensated with spectacles.

The appearance of “scissor” shadows can be seen while performing retinoscopy, Charleux oil dropcan be demonstrated backlighting the mydriatric pupil.[30] Keratometry readings may appear irregular but are within the normal range. Corneal thinning, if present is normally located outside the visual axis, is also a common sign of preceding ectasia

A hemosiderin arc or circle line, known as Fleischer’s ring, is frequently seen around the cone base In moderate and advance cases of keratoconus.[31] Fleischer’s ring is suggested to be an accumulation of iron deposits from the tear film onto the cornea as a result of severe corneal curvature changes induced by the disease and/or due to modification of the normal epithelial slide process [32]. Vogt’s striae are fine vertical lines produced by compression of Descemet’s membrane, these tend to disappear when physical pressure is applied on the cornea digitally [33] or by gas permeable contact lens wear.[34] There will be increased visibility of corneal nerves. Superficial and deep corneal opacities is also common sign. Munson’s sign is a V-shape deformation of the lower eyelid on downward gaze, and Rizzuti’s sign

is a bright reflection of nasal area of limbus on directing light to the temporal limbal area, these are two signs mostly observed in advanced stages.[33] Descemet's membrane breaks have been observed in severe keratoconus, which further causes acute stromal oedema, termed as Hydrops, leading to sudden vision loss and significant pain [35]. The majority of contact lens patients eventually develop corneal scarring

Diagnosis

Keratoconus may go undiagnosed in early phases unless corneal surface assessments both posterior and anterior are undertaken using corneal tomography. In the early stages, there is altered metabolic activity that may lead to biomechanical instability and stretching of the corneal tissues.[27] there is accompanying tissue loss on further proggression. In addition, there is a loss of correlation between the anterior and posterior corneal curvature.[36] Progressive corneal thinning and distortion leads to conical or cone-shaped protrusion, which may be visible at the slit lamp in advanced cases.[37]

Corneal topography

The normal corneal surface is aspherical, ranging from mild oblate to moderate prolate in shape, with most studies suggesting the human cornea Q (asphericity) values range from 0.01 to 0.80 (mean 0.23 0.08) measured in the 4.5-mm optical zone.[38]

Topographic Maps Local corneal dioptric power values can be represented graphically as a color-coded topographic map,[39] with "warmer" colors representing higher dioptric powers (steeper

curvatures), and "cooler" colors representing lower dioptric powers (flatter curvatures). Normal corneas flatten towards the periphery, with the rate of peripheral flattening varying significantly between individuals.[40]

The color-coded contour maps of each individual have unique patterns, and the topographies of fellow eyes tend to be mirror images, or enantiomorphs.

The scale used to display corneal topography is critical for diagnostic purposes and to appreciate features that might reduce vision. Smaller dioptric intervals may lead to a distracting amount of noise, while broader intervals may smooth over and mask irregularities. Several studies have evaluated different color palettes and dioptric intervals, including the Absolute Scale[41], the Klyce/Wilson Scale,[42] The American National Standards Institute has adopted the USS,[43] and finally the Universal Standard Scale (USS).[44] which effectively visualizes regular corneal astigmatism while masking irrelevant corneal details.

Topographic parameters that arouse suspicion: astigmatism >5 diopters (D), and/or keratometry values (K1/ K2) > 48 D70; maximum keratometry (Kmax) reading >49 D; central corneal thickness (CCT) 0.50 mm.[43]

Amsler-Krumeich Classification for grading keratoconus

Stage	Findings
1	Eccentric steepening Myopia, induced astigmatism, or both <5.00 D Mean central K readings <48 D
2	Myopia, induced astigmatism, or both from 5.00 to 8.00 D Mean central K readings <53.00 D Absence of scarring Corneal thickness >400 micron
3	Myopia, induced astigmatism, or both from 8.00 to 10.00 D Mean central K readings >53.00 D Absence of scarring Corneal thickness 300e400 micron
4	Refraction not measurable Mean central K readings >55.00 D Central corneal scarring Corneal thickness < 200 micron

ABCD Grading System for classifying keratoconus

ABCD criteria	A ARC (3 mm zone)	B PRC (3 mm zone)	C Thinnest pachy (mm)	D BDVA	Scarring
Stage 0	>7.25 mm (<46.5D)	>5.90 mm (<57.25D)	>490	≥20/20	_
Stage 1	>7.05 mm (<48.0D)	>5.70 mm (<59.25D)	>450	>20/20	_,+,++
Stage 2	>6.35 mm (<53.0D)	>5.15 mm (<65.5D)	>400	<20/40	_,+,++
Stage 3	>6.15 mm (<55.0D)	>4.95 mm (<68.5D)	>300	<20/100	_,+,++
Stage 4	<6.15 mm (>55.0D)	<4.95 mm (>68.5D)	≤300	<20/400	_,+,++

High astigmatism or an asymmetrical bowtie pattern on Topography maps are suggestive of KCN. Regular astigmatism will be represented by a bowtie pattern). in with-the-rule astigmatism symmetrical bowtie is vertical, horizontal in astigmatism is against-the-rule, and diagonal with oblique astigmatism. Corneal irregularities, or deviations from the symmetrical bowtie pattern, are detected by the curvature map and described in terms of their shape: round, oval, superior steep, inferior steep, irregular, symmetric bowtie with skewed radial axis, inferiorly steep asymmetric bowtie, superiorly steep asymmetric bowtie, or asymmetric bowtie with skewed radial axis.[30]

Above mentioned patterns are risk factors for corneal ectatic disorders when accompanied by abnormal tomographic parameters. Within the 5-mm central zone, symmetrically opposite superior and inferior locations are compared. risk of corneal ectasia is more if the superior value is more than 2.50 D greater than the lower value or the inferior value is more than 1.50 D greater than the upper.[30]

The corneal apex is displaced with localized areas of steepening. There is vertical asymmetry in corneal power, skewing of radial axes above and below the horizontal meridian, and focal pachymetric thinning localized to the corneal apex.

KCN cones can be classified into 3 catagories

(1) Nipple: cone has a diameter less than or equal to 5 mm, located in the central, paracentral, or inferonasal corneal quadrant and has round morphology
(2) Oval : cone has a diameter more than 5 mm and a paracentral/peripheral location, most common being inferotemporal corneal quadrant
(3) Keratoglobus: cone involves 75% of the cornea.[30,45,46]

The Belin Ambrosio Enhanced Ectasia Display:

It is used in combination with corneal tomography. By combining elevation and pachymetric data, BAD produces a display that is more sensitive at picking up early change by comparing the data to an “enhanced best-fit sphere.” The BAD on the Pentacam (Oculus GmbH) displays the anterior and posterior elevation data relative to the best-fit sphere calculated with a fixed optical zone of 8.0 mm, omitting the 4 mm around the elevated cone.[47] It performs regression analysis including standard deviation from the mean on changes in anterior and posterior elevations, corneal thickness at the thinnest point, thinnest point displacement, and pachymetric progression. Using all the values, BAD creates a new map, to represent variations from the mean using colours. This “difference map” depicts change in elevation as a series of concentric green, yellow, and red circles. Green represents a change of less than 5 mm on the anterior surface and 12 mm on the posterior surface of the cornea; yellow a change of 5-7 mm for the anterior surface and 12-16 mm for the posterior surface; and red greater than 7 mm anteriorly and greater than 16 posteriorly.

Corneal tomography:

It permits a detailed quantitative examination of both the anterior and posterior corneal surfaces. The posterior corneal surface has to be examined for early elevation changes, ectasia, and stromal thinning, as these are often the first clinically detectable structural changes as epithelial remodeling, which may hide an early cone, usually masks early anterior surface changes.[48] There is evidence to suggest changes in corneal epithelial thickness patterns can aid in the diagnosis of preclinical disease.[43] Reinstein and colleagues used the Artemis very high frequency ultrasound scanner to demonstrate that an epithelial doughnut pattern suggests the presence of an underlying stromal cone.[48]

Established stages are characterized by increased steepening of both anterior and posterior corneal surfaces. Areas or zones of increased power may be surrounded by adjacent areas of decreased corneal power,[49,50] especially in the adjacent hemi-meridian in cases with noncentral cones.

There are various indices which help in the diagnosis of KCN from the normal cornea, such as differences in the central K value, inferior-superior (I-S) index, KISA index, and keratoconus prediction index.[51,52]

Corneal pachymetry

Corneal thickness is importance in keratoconus diagnosis. Comparison of overall corneal thickness, the location of the apex, and thinnest point in each cornea is crucial. Values for similar superior and inferior locations in the same cornea and the thinnest point in either eye should not differ by more than 30 mm. General pachymetry thickness including the thinnest point should not differ by more than 10 mm between left and right eyes. Thinnest point is displaced inferiorly or inferotemporally, in keratoconus.

Clinical diagnosis of moderate to advanced keratoconus is not difficult because of characterstic topographic pattern and classical signs.

However diagnosing early keratoconus in patients with normal BSCVA and minimal or no clinical signs can be challenging.

Early keratoconus diagnosis is especially important in preoperative screening for laser refractive surgeries because undetected corneal ectactic disorders can result in accelerated, progressive keratoectasia and unpredictable outcomes after LASIK and photorefractive keratectomy.

Form fruste keratoconus is subclinical disease not a variant of keratoconus. Terms like “mild keratoconus”, “early keratoconus”, “subclinical keratoconus” are not universaly accepted. It is known that forme fruste keratoconus is an incomplete, abortive or unusual form of disease, with topographic features that are insufficient for inclusion of those corneas in a keratoconus suspicious category. Contralateral corneas of patients with unilateral keratoconus, and it is important to evaluate these eyes carefully as the condition might progress.[53]

Diagnosis of keratoconus is clinical on the other hand diagnosis of form fruste keratoconus is topographic. There are no specific laboratory tests or numbers generated by diagnostic instruments that can make the diagnosis.

Unrecognized early stage keratoconus is the leading cause of iatrogenic ectasia after laser in situ keratomileusis (LASIK) and remains major challenge of preoperative refractive surgery screening.[54]

Haque et al reported that the central epithelial thickness in individuals with keratoconus was 4.7 micron thinner than the control thickness.[55]

Reinstein et al found that the central epithelial thickness in keratoconic eyes, 45.7±5.9 micron was significantly thinner than in normal eyes.[56]

Histopathologic analysis of corneal ectasia have shown thinning of the epithelium, usually overlying the steepest portion of the cornea, breaks in Descemet’s membrane, fragmentation of Bowman layer, and

scarring. The corneal epithelium has a rapid cell turnover and is highly reactive to asymmetries in the shape of the underlying stromal surface. Epithelial layer remodeling may therefore have a significant impact in corneal topographic measurements, corneal warpage patterns, and early detection of corneal ectatic processes.[57]

The incidence of progressive corneal ectasia after LASIK has been estimated to be 0.2% (Rad et al., 2004).[58] Current theories suggest that the two main causes of post-LASIK ectasia are preexisting corneal pathology (keratoconus or forme fruste keratoconus), mechanical instability produced by the weakening of the residual corneal stromal bed induced by the flap creation, the effect of laser ablation, and probably eye rubbing. Careful pre-operative assessment of the cornea can greatly reduce the risk of ectasia, although it may occur in previously healthy and unsuspected corneas.

Moreover, the early detection of keratoconus could assist in decision making, such as when assessing the need for early intervention with corneal collagen crosslinking treatments. Corneal topography is currently the gold standard to evaluate ectatic corneal disorders such as keratoconus and pellucid marginal degeneration (PMD).[54]

Clinicians report eyes with normal topography and no other known risk factors that still develop post LASIK kerectasia.

It is likely that corneal topography does not capture all cases at risk. More recently, researchers have found that the corneal epithelium remodels in response to underlying stromal irregularities. Therefore, analysing the corneal epithelium and stroma separately might provide additional information for the diagnosis of keratoconus.

AIMS & OBJECTIVES

- To evaluate the usefulness of corneal epithelial thickness profile using spectral domain optical coherence tomography (SDOCT) in keratonus.
- To find some reliable and definite parametres from corneal pachymetery maps that can help in early diagnosis of keratoconus.

REVIEW OF LITERATURE

Haque S, Simpson T, Jones L. in 2006 compared corneal thickness measurements in individuals with keratoconus by using optical coherence tomography (OCT), Orbscan II, and ultrasonic pachymetry and to measure epithelial and stromal thickness in these individuals using OCT. Twenty individuals with keratoconus and 20 controls (without keratoconus) were enrolled. The Orbscan II was used to locate the steepest area of the cornea, which was taken to represent the cone apex. Each instrument was used to obtain four total corneal thickness measurements-from the cone apex, corneal center, mid-nasal, and mid-temporal cornea. Optical coherence tomography scans were analyzed to provide epithelial and stromal thickness readings. In individuals with keratoconus, mean central corneal thickness (CCT) measured by ultrasonic pachymetry, Orbscan, and OCT was 494.2 ± 50.0 microm, 438.6 ± 47.7 microm, and 433.5 ± 39.7 microm, respectively. The central keratoconic cornea was 57.7 microm thinner than the normal cornea (post-hoc P<.001). The cone apex was thinner than the central cornea (P<.001). Keratoconic epithelium was 48.2 ± 5.5 microm centrally and 42.1 ± 4.5 microm at the apex. Central keratoconic epithelium was 4.7 microm thinner and central keratoconic stroma was 57.8 microm thinner than the normal cornea (P<.001, respectively). Comparing instruments, Orbscan and OCT correlated in CCT measurement (r=0.890) and apical thickness (r=0.846). All instruments produced similar readings for mid-nasal and mid-temporal corneal thickness in participants with keratoconus (P>.05).[55]

Yan li et al [1] conducted a study in 2012 to map the corneal epithelial thickness with Fourier- domain optic coherence tomography (optic) and to develop epithelial thickness-based variables for keratoconus detection on one hundred forty-five eye from 76 Normal subject and 35 keretoconic eye from 22 patients. A 26 000-HZ Fourier- domain Oct system with 5 micron axial resolution was used. The corneal was imaged with a pachymetry+cpwr scan pattern (6-mm scan diameter, 8

radials, 1024 axial-scans each, repeated 5 time) centered on the pupil. Three scan were obtained at a single visit in prospective study. A computer algorithm was developed to map the corneal epithelial thickness automatically. Zonal epithelial thickness and 5 diagnostic variable, including minimum, superior-inferior (S-I), minimum-maximum, map standard deviation (MSD) and pattern standard deviation (PSD), were calculated. Repeatability of the measurement (MIN-Max), map standard assessed by the pooled standard deviation. The area under the receiver operation characteristic curve (AUC) was used to evaluation diagnostic accuracy. The central, superior, and inferior epithelial thickness averages were 52.3±3.6 micron ,49.6±3.5 micron and 51.2±3.4 micron in normal eye and 51.9±5.3 micron 51.2±4.2 micron and 49.1±4.3 mocron in keratoconic eye. Compared with normal eye, keretoconic eye had significantly lower inferior (P= 0.03) and minimum (P<0.0001) corneal epithelial thickness, greater S-I (P=0.013), more negative MIM-MAX (P<0.0001), greater MSD (P<0.0001), and larger PSD (P<0.00001). The repeatability of MSD was better than 0.4 micron. The repeatability of PSD was 0.02 or better. Among all epithelial thickness-based variables investigated, PSD provided the best diagnostic power (AUC=1.00). using a PSD cutoff value of 0.057 alone gave 100% specificity and sensitivity. High-resolution Fourier-domain OCT mapped corneal epithelial thickness with good repeatability in both normal and keratoconic eye. Keratoconus was characterized by apical epithelial thinning. The resulting deviation fom the epithelial pattern could be detected with very high accuracy using the PSD variable.

Karolinne maria rocha, MD, PhD et al in 2013[59] conducted study to assess corneal microarchitecture and region epithelial thickness profile in eyes with keretoconus, postoperative corneal ectasia, and normal unoperated eyes using spectral-domain optical coherence tomography (SD OCT). Regional corneal epithelial thickness Profiles of eyes with keratoconus and postoperative corneal ectasia were measured with anterior segment SC OCT (optovue RTVue-100, optovue Inc.,

Fremont, CA) and compared retrospectively to those of normal eyes (control). Epithelial thickness was assessed at 21 point, 0.5 mm apart, across the central 6-mm of the cornel apex in the horizontal and meridians. one hundred twenty eyes were evaluated, including 49 eyes from 29 patients with KC, 32 eyes from 16 patient with Ectasia, and 39 eyes from 21 control patients. Average epithelial thickness at the corneal apex was 41.8±6.47micron (range 30 to 51) in eyes with KC, 46.5±6.72 micron in eyes with ectasia (range 34 to 60 micron) and 50.45=\-3.92 micron in the eyes (range 42 to 55 micron). Apical epithelial thickness was significantly thinner in eyes with KC (p<.0001) and ectasia (p=.0007) than it was in controls. Epithelial thickness range in all other areas varied widely for KC (SD, range 21 to 101 micron) and actasia (SD, range 30 to 82 micron) compared to controls (SD, range 43 to 64),p=.0063. Central epithelial thickness was, on average, significantly thinner in ectasic corneas compared to control; however, both central and regional epithelial thickness was highly irregular and variable in corneas with keratoconus and postoperative corneal ectasia. These thickness variations may alter preoperative topographic features and measurements in unpredictable ways, especially steepest K values. Regional epithelial thickness cannot be assumed to be unifrom in ectatic corneas and therefore may require direct measurement whe considering treatment for which stromal thickness is particularly important, such as corneal collagen cross-linking or topography- guided laser ablation.

Shinichi fukuda et al[53] conducted a study in 2013 to evaluation the ability of parameters measured by three- dimension (3D) corneal and anterior segment optical coherence tomography (CAS-OCT) and a rotating scheimpflug camera combined with a placido topography system (scheimpflug camera with topography) to discriminate between normal eyes and from fruste keratoconus. Forty- eight of 48 patients with keratoconus, 25 eyes of 25 patient with from fruste keretoconus and 128 normal subjects were evaluated. Anterior and posterior keratometric. Parameter (steep K, flat K, average K), evelvation,

topographic parameters, regular and irregular and irregular astigmatism (spherical, asymmetry, regular and higher order astigmatism) and five pachymetric parameter (minimum, minimum-median, inferior- superior , inferotemporal- superonasal , vertical thin newest location of the corneal) were measurement using 3D CAS-OCY and a scheimpflug camera with topography. The area under the receiver operation curve (AUROC) calculated to assess the discrimination ability. Compatibilty and repeatability of both devices were evaluation. Posterior surface elevation showed higher AUROC value in discrimination analysis of frome fruste keratoconus using both devices. Both instrument showed significant linear correlation ($p<0.05$, person's correlation coefficient) and good repeatability (LCCs: 0.885- 0.999) for normal from fruste keretoconus. Posterior elevation was the best discrimination parameter for from fruste keretoconus. Both instrument presented good correlation and repeatability for this condition.

In 2013 Rocha KM, Perez-Straziota CE, Stulting RD, Randleman JB.[57] Conducted study to assess corneal microarchitecture and regional epithelial thickness profile in eyes with keratoconus, postoperative corneal ectasia (ectasia), and normal unoperated eyes (controls) using spectral-domain optical coherence tomography (SD-OCT). Regional corneal epithelial thickness profiles were measured with anterior segment SD-OCT (Optovue RTVue-100, Optovue Inc., Fremont, CA). Epithelial thickness was assessed at 21 points, 0.5 mm apart, across the central 6-mm of the corneal apex in the horizontal and vertical meridians. One hundred twenty eyes were evaluated, including 49 eyes from 29 patients with keratoconus, 32 eyes from 16 patients with ectasia, and 39 eyes from 21 control patients. Average epithelial thickness at the corneal apex was 41.18 ± 6.47 μm (range: 30 to 51 μm) for keratoconus, 46.5 ± 6.72 μm for ectasia (range: 34 to 60 μm), and 50.45 ± 3.92 μm for controls (range: 42 to 55 μm). Apical epithelial thickness was significantly thinner in eyes with keratoconus ($P < .0001$) and ectasia ($P = .0007$) than in controls. Epithelial thickness ranges in

all other areas varied widely for keratoconus (range: 21 to 101 μm) and ectasia (range: 30 to 82 μm) compared to controls (range: 43 to 64) (P = .0063). SD-OCT demonstrated significant central and regional epithelial thickness profile differences between keratoconus, ectasia, and control eyes, with significant variability and unpredictability in ectatic eyes. This regional irregularity may necessitate direct epithelial thickness measurement for treatments where underlying stromal variations may be clinically relevant, including corneal collagen cross-linking or topography-guided ablations.

Cyril Temstet, MD et al conducted study in 2015 to determine whether optical coherence tomography (OCT) epithelial mapping can improve the detection of form fruste keratoconus. Eyes with normal corneas, form fruste keratoconus, moderate keratoconus, or severe keratoconus were assessed using Fourier-domain OCT (RTVue 5.5), scanning-slit corneal topography (Orbscan IIz), and rotating Scheimpflug camera (Pentacam Comprehensive Eye Scanner). Several parameters provided by the software or derived from elevation maps, OCT.[60] Pachymetric maps, and OCT epithelium parameters were evaluated and compared between the 4 groups. The study involved 145 eyes. There were no significant differences in the keratometry (K) value, inferior–superior value, keratoconus index, central K index, and topographic keratoconus classification indices between the form fruste keratoconus group and the control group (P > .05). Form fruste keratoconic corneas had less epithelial thickness in the thinnest corneal zone than normal corneas, and greater epithelial thickness in the thinnest corneal zone than keratoconic corneas (P < .005). The epithelial thickness in the thinnest corneal zone in form fruste corneas was located inferiorly (P < .005) and corresponded with the zone of minimum epithelial thickness and maximum posterior elevation (P < .005). The receiver operating characteristic curve analysis showed good over-all predictive accuracy of the epithelial thickness in the thinnest corneal zone, with a 52 mm threshold value for discriminating form fruste keratoconic corneas from normal corneas.

Yan li et al[54] conducted another study recently in 2016 to screen for subclinical keretoconus by analyzing corneal, epithelial, and stromal thickness map patterns with Fouies- domain optical coherence tomography (OCT). Eyes of normal subjects, subclinical keratoconus eyes, and the topographically normal eye of a unilateral keratoconus patient were studied. Corneal were scanned using a 26000 Hz Fouries-domain OCT system (RTVue). Normal subjects were divided into training and evaluation groups. Corneal, epithelial, and stromal thickness maps and derived diagnostic including pattern standard deviation (PSD) variables and pachymetery map based. Keretoconus risk scores were calculate from the OCT data. Area under the receiver operating characteristic curve (AUC) analysis was used to evaluated the diagnostic accuracy of the indices. The study comprised 150 eyes of 83 normal subjects, 50 subclinical keratoconus eyes of 32 patients, and 1 tomography normal eye of a unilateral keratoconus patient. Subclinical keratoconus was characterized by inferotemporal thinning of the cornea, epithelium and stroma. The PSD values for corneal ($p<.001$), epithelial ($p<.001$), and stromal ($p=.049$) thickness maps were all significantly higher in subclinical keratoconus eyes than in the normal group. The diagnostic accuracy was significantly higher for PSD variables (pachymetric PSD, AUC=0.941; epithelial PSD, AUC=0.985; stromal PSD, AUC=0,924) than pachymetric map-based keratoconus risk score (AUC=0,735). High- resolution Fourier-domain OCT could map corneal, epithelial, and stromal thickness. Corneal and sub layer thickness changes in subclinical keratoconus could be detection with high accuracy using PSD variables. These new diagnostic variables might be useful in the detection of early keratoconus.

MATERIALS AND METHODS

This study is aimed at proving the diagnostic efficacy of anterior segment OCT in keratoconus and forme fruste kertoconus.

It's a cross sectional observational study, subjects were recruited from department of ophthalmology at Dayanand Medical College and hospital from January 2018 to June 2019.Three groups were formulated GROUP A comprising of normal subjects, recruited from volunteers, patients seeking refractive surgery consultation. All having normal slit lamp findings and normal topographic features. GROUP B comprising of Keratoconus eyes.

Inclusion Criteria:

Keratoconic eyes included in the study were diagnosed on the basis of clinical evaluation and tomography. Rabinowitz has suggested four quantitative videokeratographic indices for screening keratoconic patients. 25 These indices include central corneal power >47.2 D, inferior-superior dioptric asymmetry over >1.2 D, Sim-K astigmatism >1.5 D and skewed radial axes $>21^{0}$[61]

Each case had corrected visual acuity of 20/25 or worse and had at least 1 clinical sign other than the keratoconic appearance of topography map (asymmetric bow-tie with skewed radial axis, central or inferior steep zone or claw shape). Keratoconic slit lamp finding included munson's sign, vogt's striae, Fleischer's ring, apical scar, apical thinning and scissoring reflex on retinoscopy.

C. Exclusion Criteria:

- Previous ocular surgery/trauma
- Associated corneal pathologic features (scaring, hydrops)
- History of collagen crosslinking
- Intrastromal corneal ring segment
- Keratoplasty/ other corneal surgery
- Contact lens wear during the previous 3 weeks

GROUP C included eyes with FORME FRUSTE KERATOCONUS.
Subclinical keratoconic eyes with no slit lamp findings, BCVA of 20/25 or better, topographical normal eye of unilateral keratoconus. Exclusion criteria was same as that for keratoconus
Corneal topography was done with pentacam. The Pentacam® is a rotating Scheimpflug camera system for anterior segment analysis. It measures topography and elevation of the anterior and posterior corneal surface and the corneal thickness. Basic Software includes Overview display, Fast Screening Report, 1 Large Map, 4 Maps Refractive, Scheimpflug Image Overview, Virtual Eye, Tomography, Iris Image, Topometric and Comparison displays.

Optical coherence tomography (OCT) is an optical acquisition method to examine biological tissues. In recent years, OCT has become an important imaging technology used in diagnosing and following macular pathologies. Further development enabled application of optical coherence tomography in evaluation of the integrity of the nerve fiber layer, optic nerve cupping, anterior chamber angle, or corneal topography.

Optical coherence tomography (OCT) systems use low-coherence, near-infrared light to provide detailed images of anterior segment structures at resolutions exceeding other systems like ultrasound biomicroscopy or conventional ultrasound. The Cirrus spectral-domain equipment (Carl Zeiss Meditec, Dublin, CA, USA) is an around 5 micra high-definition (HD) 840 nm spectral-domain OCT instrument primarily designed for retinal imaging.

The HD-OCT device has been recently used as a noninvasive corneal imaging modality that was capable of in vivo differentiation of both corneal layers and demonstration of pathologic abnormalities in the cornea. Corneal indications for the Cirrus OCT can be divided into pachymetry analysis, keratectomy, refractive surgery, structural, and contact lens abnormalities. For pachymetry, the Anterior Segment Cube 5 1 2 × 1 2 8enables identification of the central corneal section,

which facilitates positioning for central corneal thickness measurements.

OCT Imaging	**Model 5000**
Methodology	Spectral domain OCT
Optical Source	Superluminescent diode (SLD), 840 nm
Scan speed	27,000-68,000 A-scans per second
A-scan depth	2.0 mm (in tissue), 1024 points
Axial resolution	5 µm (in tissue)
Transverse resolution	15 µm (in tissue)

TOPOGRAPHIC INDICES:

K1 : Flat Keratometry

K max: keratometry at steepest point

Astigmatism

Thinnest pachymetry of cornea

Pachymetry at the centre of pupil

Pachymetry at the apex of cornea

Ambrosio relational thickness(ART): it's the thinnest point divided by pachymetric proression index. ART metrics are best for keratoconus diagnosis

D value: final deviation value

ASOCT indices:

Minimum epithelial thickness

Minimum-median pachymetry

Superonasal and inferotemporal asymmetry

Inferosuperior asymmetry

Central epithelial thickness

Thinnest epithelial thickness

Central- minimum epithelial thickness

OUTCOME

Sensitivity and specificity of pachymetry maps (ASOCT) in corneal epithelial thickness profile and its role in early diagnosis of keratoconus and forme fruste keratoconus by evaluating different indices of pachymetry maps

OBSERVATIONS & RESULTS

Data were described in terms of range; mean ±standard deviation (± SD), frequencies (number of cases) and relative frequencies (percentages) as appropriate.

Comparison of quantitative variables between the study groups was done using ANOVA.

For comparing categorical data, Chi square ($\chi 2$) test was performed and exact test was used when the expected frequency is less than 5.

Receiver operator characteristics (ROC) curve was done, and criterion value was estimated depending on the specificity and sensitivity. Area under curve (AUC) was measured.

Bland Altman plots (difference vs range) were used to compare various instruments

A probability value (*p* value) less than 0.05 was considered statistically significant.

All statistical calculations were done using SPSS (Statistical Package for the Social Science) SPSS 21 version statistical program for Microsoft Windows

A total of 104 cases were diagnosed as Keratoconus based on clinical assessment and corneal topography. Out of these, 189 eyes of 95 patients had Keratoconus and rest of 19 eyes of 18 patients were diagnosed as Forme Fruste Keratoconus. These two subgroups were compared with control group of 112 eyes from 56 patients for the following parameters:

- Demography
- BCVA
- History
- Ocular examination
- Topography
- ASOCT

DEMOGRAPHY

In KCN group out of 86 patients 51 were male and 35 were females.

In FFKCN group out of 18 patients 14 were males and 4 females

TABLE 1: GENDER DISTRIBUTION

		Group			Total	Chi-square value	p-value
		KCN	FFKCN	CONTROL			
Gender	F	35	4	30	69	5.905	0.052
	M	51	14	26	91		
Total		86	18	56	160		

KCN

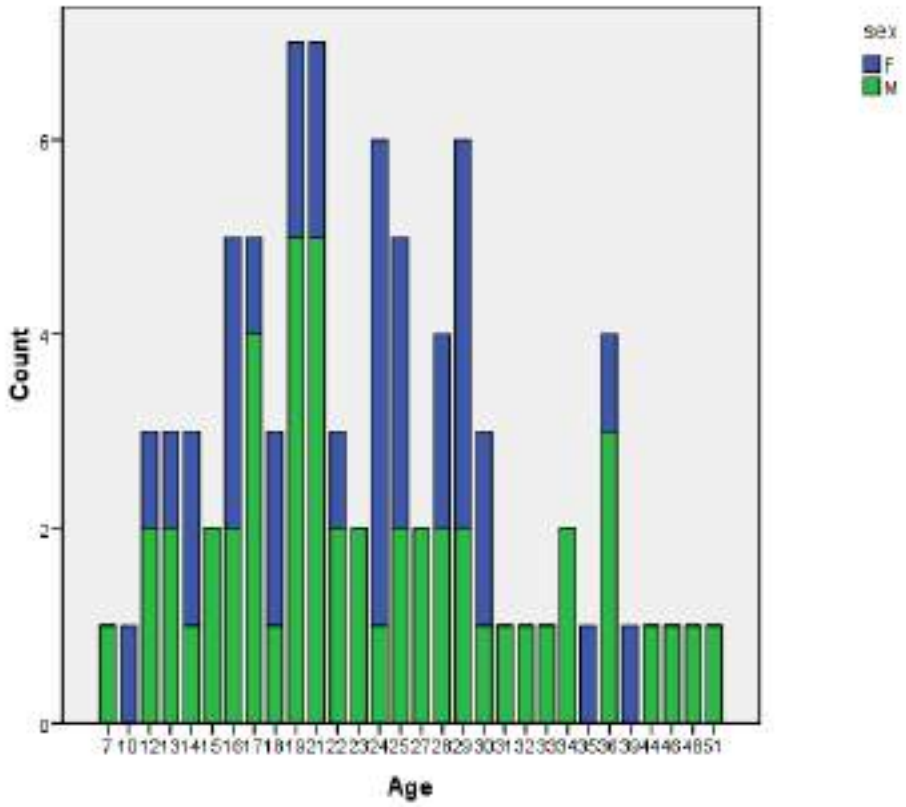


FIGURE 1: AGE & GENDER DISTRIBUTION IN KCN GROUP

TABLE 2: BSCVA IS STUDY GROUP

BSCVA could be obtained for only 47 patients from medical records

BSCVA (Best Spectacle Corrected Visual Acuity)	No. of cases	Percentage
>6/12	37	78.72%
6/12-6/60	8	17.02%
6/60	2	4.26%

CLINICAL EXAMINATION:

TABLE 3: CLINICAL FINDINGS IN STUDY GROUP

On the basis of history cards available, out of 49 patients 30 had fleischer's ring, 16 had vogt's striae and 15 had scissoring reflex

	No. of cases	Percentage
FLEISCHER'S RING	19/39	38.78%
VOGT'S STRIAE	16/39	32.65%
SCISSORING REFLEX	15/39	30.61%

Table 4: Comparison of various topographic parameters based on Pentacam between KCN, FFKC and control group

Table below shows the comparison of various topographic parameters based on Pentacam between KCN, FFKC and control group

topography	KCN		FFKCN		CONTROL		F	p-value	KCN VS CONTROL	FFKCN VS CONTROL
	Mean	SD	Mean	SD	Mean	SD			p-value	p-value
K1 (Flat keratometry)	46.36	5.81	43.45	1.50	43.13	1.44	18.392	0.000	0.000	0.782
K2 (Steep keratometry)	52.96	36.04	45.24	1.87	44.08	1.60	3.729	0.025	0.009	0.867
Kmax (keratometry at steepest point)	55.09	9.04	46.62	2.69	48.08	38.52	3.575	0.029	0.014	0.804
Astigmatism	3.68	2.30	1.77	1.14	0.96	0.61	78.459	0.000	0.000	0.074
Thinnest pachymetery	443.69	73.54	508.68	27.91	531.32	65.23	57.859	0.000	0.000	0.187
Pupil center pachymetery	465.82	63.12	514.21	28.17	542.10	30.48	74.440	0.000	0.000	0.033
Apex pachymetery	459.37	56.87	520.26	26.40	542.56	30.73	107.460	0.000	0.000	0.062
ART (Ambrosio Relational Thickness)	175.37	76.02	319.68	68.12	403.39	67.27	345.870	0.000	0.000	0.000
D value(Standard deviation from mean)	13.91	59.01	2.46	1.56	1.15	0.68	2.899	0.057	0.021	0.908
FET	16.87	15.92	5.00	4.48	2.50	1.79	48.926	0.000	0.000	0.417
BET	38.78	24.36	12.47	9.70	4.50	3.88	115.573	0.000	0.000	0.094

ANOVA for KCN vs FFKCN was 18.392, 78.459 for K1 and astigmatism respectively with p value of 0.000 for the parameters. FFKCN group values were not significant in either of the parameters. Thinnest Pachymetery, pachymetery for pupil centre and apex had ANOVA values of 57.859, 74.440 and 107.460 respectively all with p value of 0.000. ART, FET, BET had ANOVA values of 345.870, 48.926 and 115.573 respectively, p value for all being 0.000

ASOCT parameters representing epithelial thickness profile were mainly studied. Table below shows the various indices

TABLE 5: COMPARISON OF VARIOUS EPITHELIAL THICKNESS PARAMETERS BASED ON ASOCT BETWEEN KCN, FFKC AND CONTROL GROUP

ASOCT	KCN		FFKCN		CONTROL		F	p-value	KCN VS CONTROL	FFKCN VS CONTROL
	Mean	SD	Mean	SD	Mean	SD			p-value	p-value
Min. epithelial thickness	33.46	5.00	31.39	5.63	33.38	5.94	1.219	0.297	0.900	0.148
Min-Median (minimum epithelial thickness – median epithelial thickness)	-16.93	47.14	-5.37	2.19	-6.04	6.72	3.499	0.031	0.013	0.940
SN-IT asymmetry(superonasal – inferotemporal)2.0-5.0 mm	4.98	7.21	0.53	3.88	-0.13	2.26	28.854	0.000	0.000	0.649
Central epithelial thickness	46.78	8.54	46.84	4.15	49.97	10.23	4.572	0.011	0.003	0.162
Thinnest corneal thickness	352.44	164.77	433.63	122.81	494.94	83.71	37.122	0.000	0.000	0.077
Central-Min	13.47	9.06	15.39	5.37	16.61	11.53	3.494	0.032	0.009	0.626
I-S (inferior superior asymmetery)2-5.0 mm	1.87	6.77	-0.37	3.90	-1.67	2.74	14.413	0.000	0.000	0.343

Min- median (minimum epithelial thickess-median epithelial thickness) is a parameter available on epithelial thickness maps in zeiss cirrus 5000 and the mean of this parameter was -16.93, -5.37 and -6.04 in KCN, FFKCN and control groups respectively.

In KCN the AUC was 0.826 and p value of 0.000. the minimum cuttoff value above which it was statistically significant came out to be -8.50 micron with sensitivity of 90.4% and specificity of 55.5%.

In FFKCN min.-median thickness didn't came out to a significant parameter, AUC being 0.575 with p value of 0.338. minimum cuttoff came out to be -6.50 micron with sensitivity of 81.7% and specificity of 31.3%

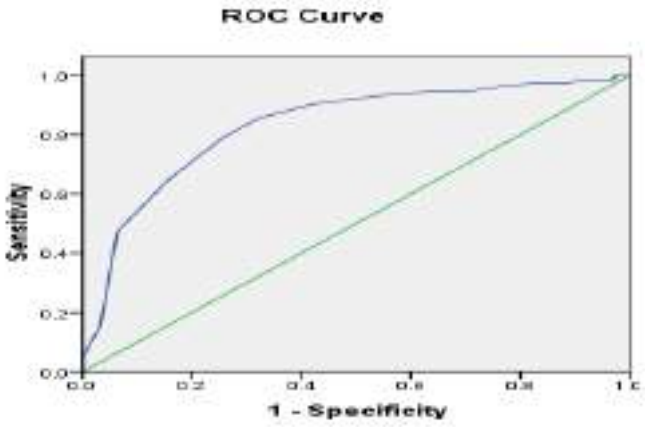


FIGURE 2: ROC COURE FOR MIN- MEDIAN IN KCN GROUP

KCN

Mean SN-IT asymmetry (superonasal-inferotemporal) at 2-5mm zone was 4.98, 0.53 and -0.13 in KCN, FFKCN and control group respectively

In KCN group AUC was 0.783 with p value of 0.000. minimum cutt off value was +.50 with sensitivity of 77.8% and specificity of 58.6%

In FFKCN group AUC was 0.579 with p value of 0.270. minimum cutt off was -0.50 with sensitivity of 68.4% and specificity 42.3%

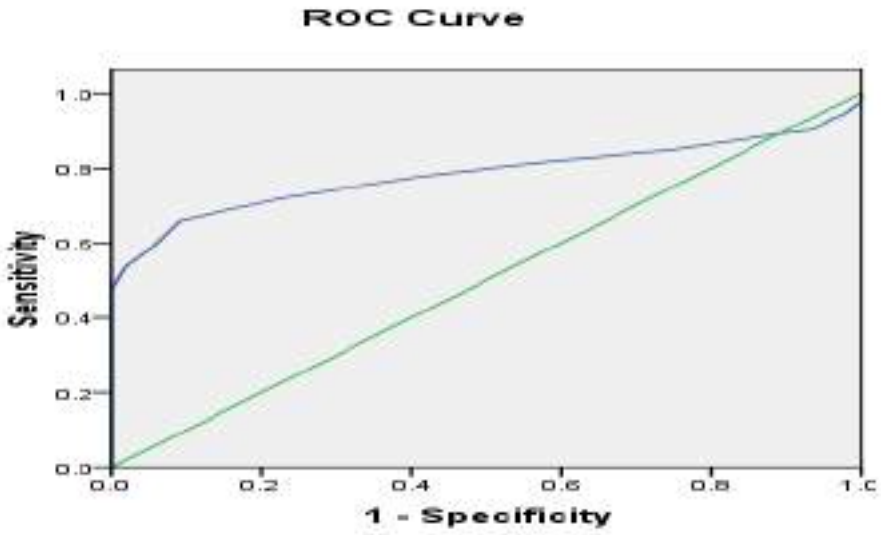


FIGURE 3: ROC CURVE FOR SN-IT KCN GROUP

Central epithelial thickness was another parameter which is significant is this study. Mean of central epithelial thickness was 46.78±8.54 micron and AUC was 0.725 with p value of 0.000 in KCN. Minimum cut off value was 45.50 micron with sensitivity of 91.1% and specificity 52.7%

In FFKCN mean was 46.84±4.15 micron and AUC was 0.746 with p value of 0.001. Minimum cut off 46.50 micron with sensitivity 85.7% and specificity 42.1%

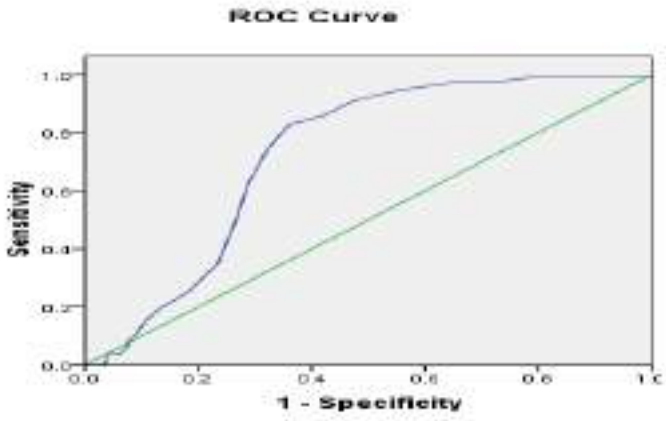


FIGURE 4: ROC CURVE FOR CENTRAL EPITHELIAL THICKNESS KCN GROUP

I-S asymmetry in 2.0-5.0 mm had mean value of 1.87±6.50 in KCN. Minimum cut off value was -1.50 micron with sensitivity of 71.0% and specificity of 57.3%

AUC was 0.701 with p value of 0.000 in KCN and 0.628 with p value of 0.075 in FFKCN. Minimum cut off value was -1.50 micron with sensitivity 63.2% and specificity 57.3%

In this study we tried to find some new parameter that could help in KCN and FFKCN diagnosis with epithelial maps: central-minimum epithelial thickness

Central-minimum epithelial thickness had AUC of 0.682 with p value of 0.000 in KCN, minimum cut off was 12.50 micron with sensitivity 80.2% and specificity of 52.3%

In FFKCN AUC was 0.580 with p value of 0.278. Minimum cut off of 14.50 micron with sensitivity of 64.9% and specificity of 55.6%

DISCUSSION

In this study we studied mainly epithelial thickness profile of keratoconus patients. Aim of study was to improve detection of keratoconus detection in combination with pentacam.

Reinstein et al. was first to use corneal epithelial mapping using VHF US (50 MHz) with a 21 mm resolution over the entire corneal surface. The central epithelial thickness in normal eyes was 53.4 ± 4.6 mm.27 In keratoconic eyes, the corneal epithelium showed an epithelial doughnut pattern characterized by localized central thinning surrounded by an annulus of thick epithelium, and the central epithelial thickness (45.7 ± 5.9 mm) was statistically significantly thinner than in normal eyes.[62]

AUC of various ASOCT indices has been compared with ART and D value from Pentacam in table below

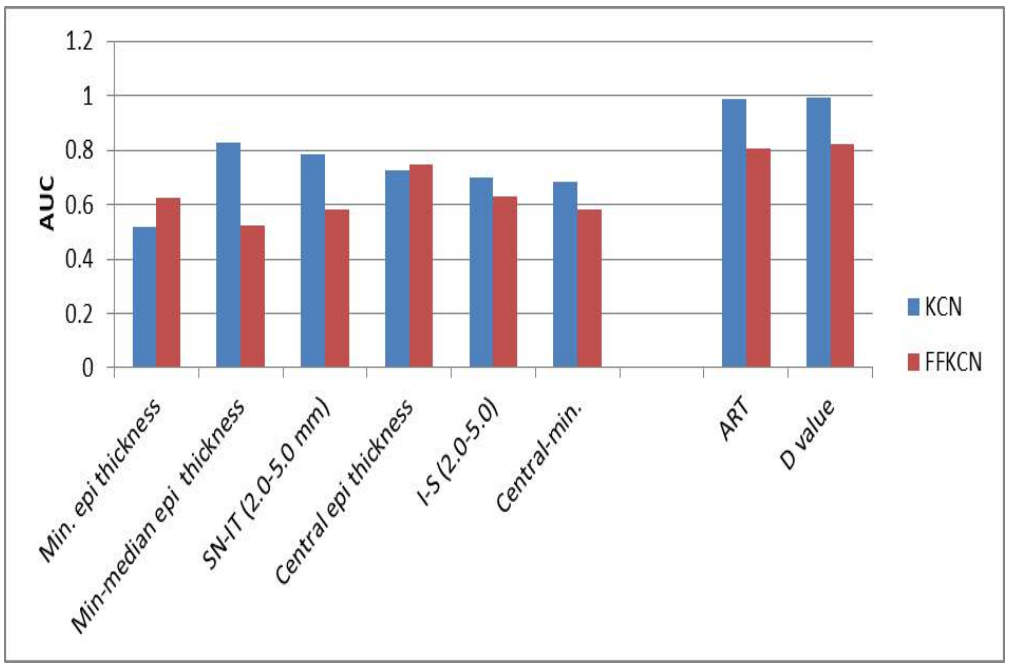
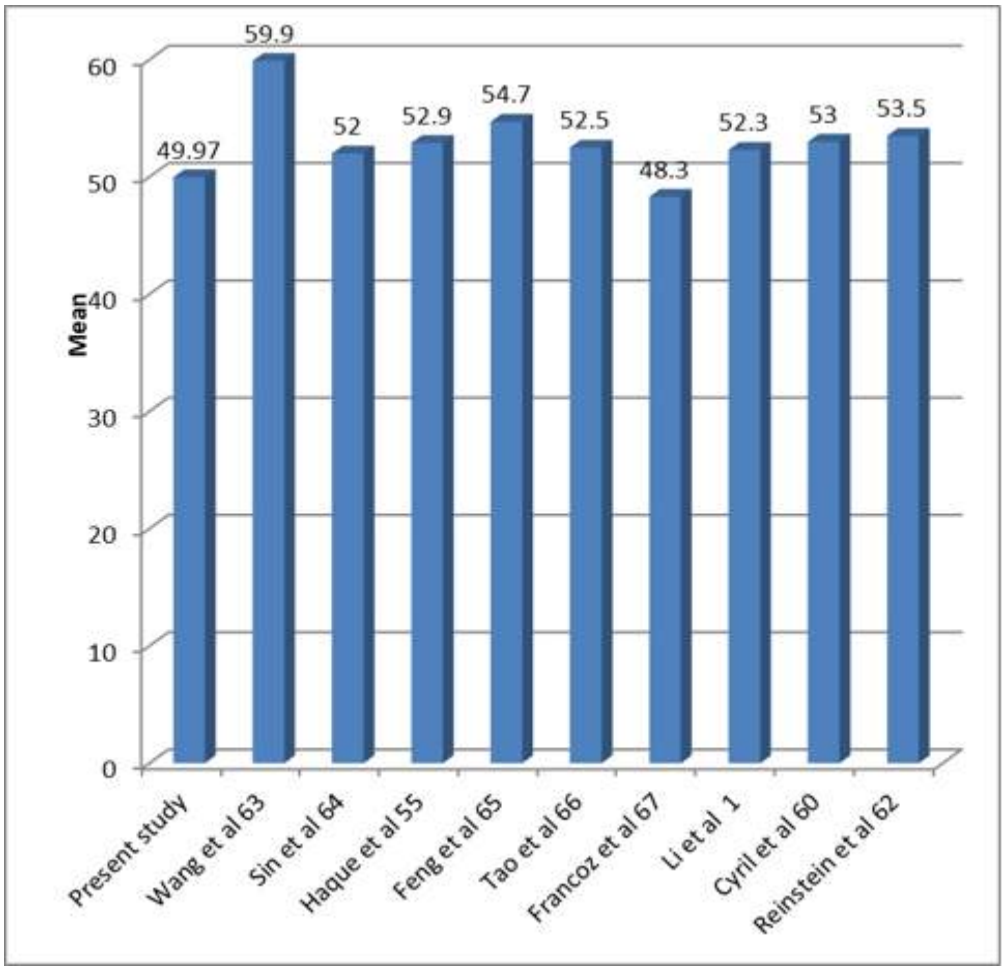


FIGURE 5: AUC OF ASOCT (EPITHELIAL THICKNESS PARAMETERS) COMPARED WITH PENTACAM PARAMETERS

FIGURE 6: COMPARISON OF MEAN CENTRAL EPITHELIAL THICKNESS IN CONTROL POPULATION REPORTED IN PREVIOUS STUDIES

Comparison of mean central epithelial thickness in control population is shown in bar chart below in various study



Mean of central epithelial thickness in KCN described in various studies

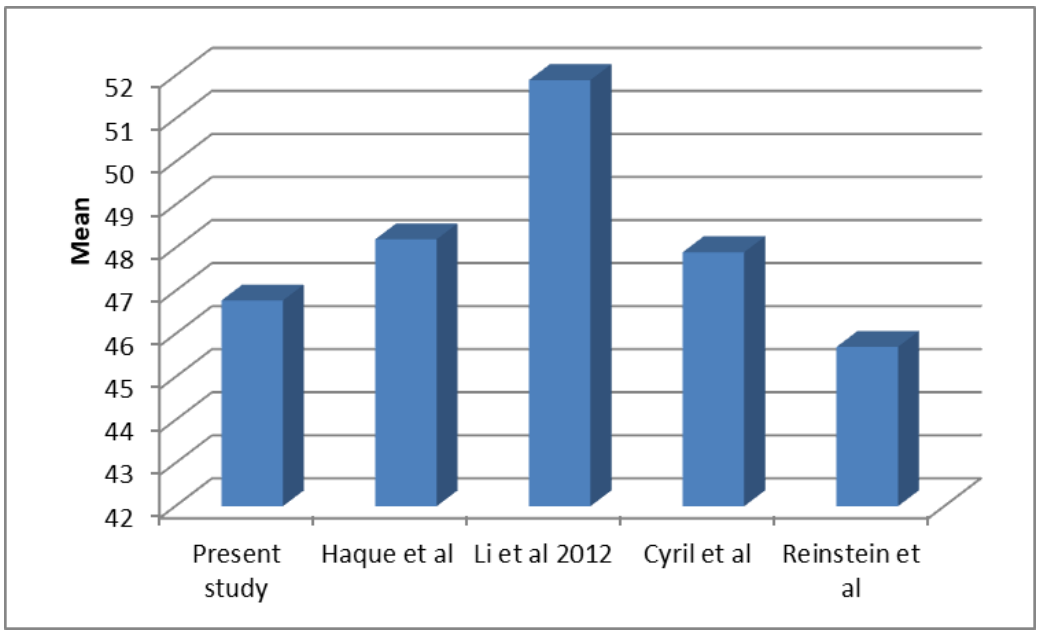


FIGURE 7: COMPARISON OF MEAN CENTRAL EPITHELIAL THICKNESS IN KCN GROUP REPORTED IN PREVIOUS STUDIES

SN-IT has also been described ina previous study (Cyril et al). In our study we took SN-IT and I-S between 2.0mm to 5.0 mm zone, rationale being keratoconus cone is mostly present in 5mm zone and secondly indices values outside 5 mm zone were not reliable.

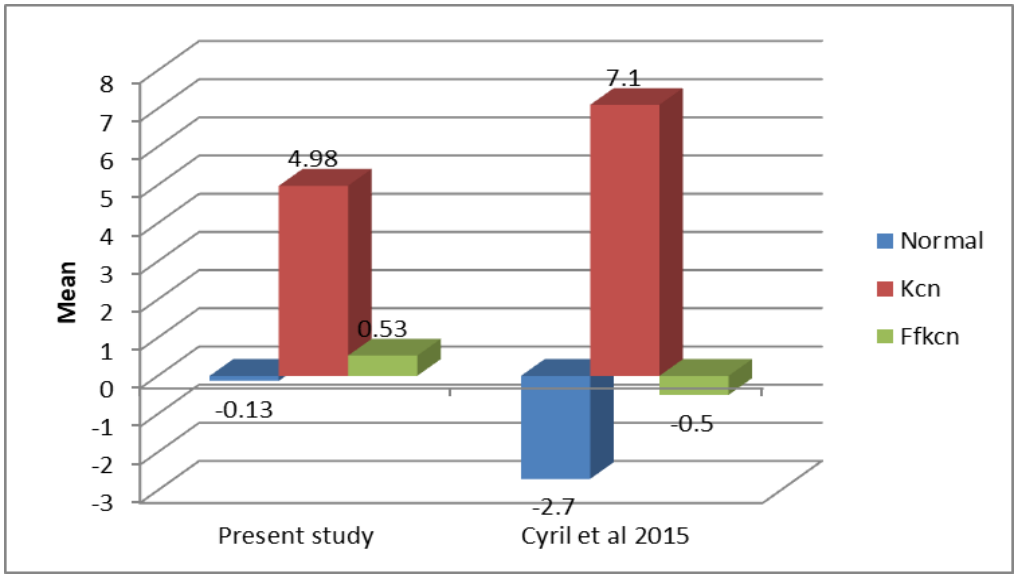


FIGURE 8: COMPARISON OF MEAN CENTRAL EPITHELIAL THICKNESS IN SN-IT IN NORMAL, KCN, FFKCN GROUP REPORTED BY CYRIL ET AL.[60]

Min-median is a new parameter described in this study. In KCN the AUC of this parameter camd out to be 0.826 and p value of 0.000. The minimum cuttoff value above which it is statistically significant came out to be -8.50 micron with sensitivity of 90.4% and specificity of 55.5%.

In FFKCN min.-median thickness didn't came out to a significant parameter, AUC being 0.575 with p value of 0.338. minimum cuttoff came out to be -6.50 micron with sensitivity of 81.7% and specificity of 31.3%

	KCN		FFKCN		CONTROL		F	p-value	KCN VS FFKCN	KCN VS CONTROL	FFKCN VS CONTROL
	Mean	SD	Mean	SD	Mean	SD			p-value	p-value	p-value
Min-Median (minimum epithelial thickness – median epithelial thickness)	-16.93	47.14	-5.37	2.19	-6.04	6.72	3.499	0.031	0.189	0.013	0.940

TABLE 6: COMPARISON OF MINIMUM- MEDIAN EPITHELIAL THICKNESS AMONG KCN, FFKCN & CONTROL

I-S asymmetery was described by li et al

TABLE 7: COMPARISON OF IS ASYMMETERY IN NORMAL KCN AND FFKCN WITH LI ET AL [1] CONTROL POPULATION REPORTED IN PREVIOUS STUDIES

I-S(2.0-5.0)			
	Normal	Kcn	Ffkcn
Present study	-1.67	1.87	0.37
Li et al 2012	-1.6	2.1	

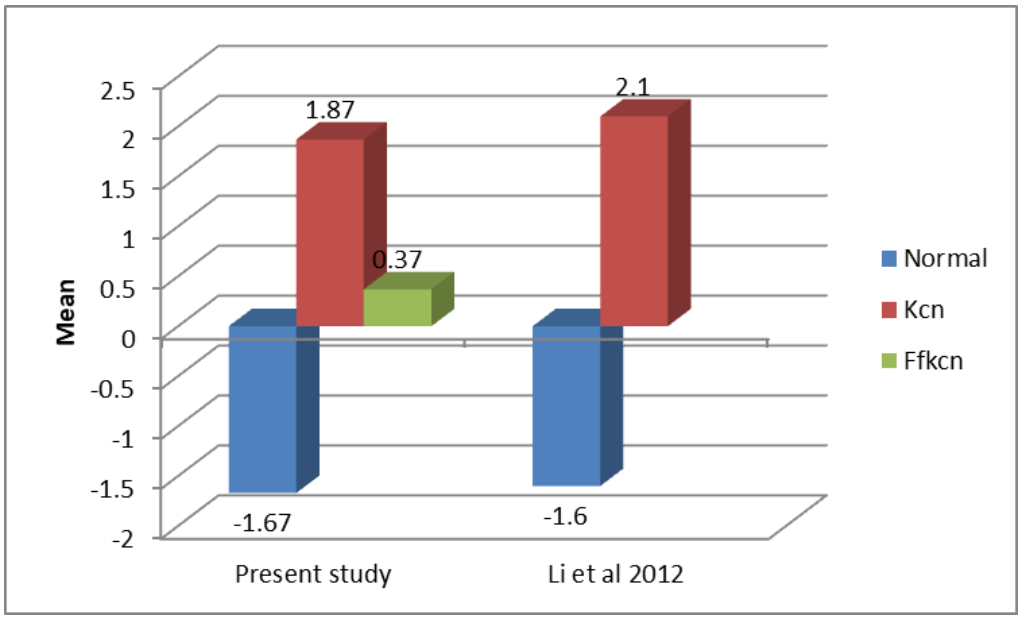


FIGURE 9: COMPARISON OF IS ASYMMETERY IN NORMAL KCN AND FFKCN WITH LI ET AL [1] CONTROL POPULATION REPORTED IN PREVIOUS STUDIES

Early diagnosis of corneal ectasia such as keratoconus is very essential in today's era, when refractive surgery is becoming common. The incidence of progressive corneal ectasia after LASIK has been estimated to be 0.2% (Rad et al., 2004).[8]. Careful pre-operative

assessment of the cornea can greatly reduce the risk of ectasia, although it may occur in previously healthy and unsuspected corneas.

Moreover, the early detection of keratoconus could assist in decision making, such as when assessing the need for early intervention with corneal collagen crosslinking treatments. Corneal topography is currently the gold standard to evaluate ectatic corneal disorders such as keratoconus and pellucid marginal degeneration (PMD).[4]

SUMMARY & CONCLUSION

In the end as per previous studies discussed in this particular study, it is very clear and evident that corneal epithelial mapping has association with corneal ectasias and it can help in early diagnosis in association with pentacam, thus preventing PLE and other post refractive surgery complications.

Our study provided a new statistically significant indices for epithelial mapping (min-median) but it lacks the ability to be a absolute criterion. Further studies on epithelial mapping are required.

Clinicians report eyes with normal topography and no other known risk factors that still develop post LASIK kerectasia.

It is likely that corneal topography does not capture all cases at risk. More recently, researchers have found that the corneal epithelium remodels in response to underlying stromal irregularities. Therefore, analysing the corneal epithelium and stroma separately might provide additional information for the diagnosis of keratoconus.

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Cirrus HDOCT

Cornea External Lens for ASOCT

PENTACAM

Sr. No	Name Initial	Group	Age	Gender	MRD No	History								
						Chief Complaint	H/O VKC	AGE OF ONSET OF VKC	AGE OF KCN DIAGNOSIS	SPECTACLE H/O	FREQUENCY OF CHANGE OF GLASSES	UCVA (Un Corrected Visual Acuity)	BSCVA (Best Spectacle Corrected Visual Acuity)	CURRENT REFRACTION
1	H	cases	35	F	511074	DOU B/E	-	-	34	Y	M	-	-	-5.00/-4.50x80
2	KT	cases	25	F	731113	DOU B/E	-	-	26	Y	M	6/6 (P)	-	-
3	P	cases	14	M	399242	-	-	-	-	-	-	-	-	-
4	RK	cases	36	M	333294	-	-	-	-	-	-	-	-	-
5	Y	cases	18	M	463262	-	-	-	-	-	-	-	-	-
6	N	cases	19	M	338663	-	-	-	-	-	-	-	-	-
7	AS	cases	21	M	727741	-	-	-	-	-	-	-	-	-
8	AS	cases	18	M	517911	-	-	-	-	-	-	6/9	6/6	-1.50x35
9	AK	cases	36	M	9112	-	-	-	-	-	-	-	-	-
10	A	cases	31	M	548248	-	-	-	-	-	-	-	-	-
11	A	cases	25	F	68301	-	-	-	-	-	-	-	-	-
12	AJ	cases	16	M	700550	-	-	-	-	-	-	6/6	6/6	-
13	A	cases	21	M	299645	-	-	-	-	-	-	-	-	-
14	B	cases	34	M	742343	-	-	-	-	-	-	-	-	-
15	BS	cases	23	M	562255	-	-	-	-	-	-	-	-	-
16	B	cases	15	M	173796	-	-	-	-	-	-	-	-	-
17	B	cases	34	M	742343	-	-	-	-	-	-	-	-	-
18	C	cases	24	M	460411	DEUTEASL OF VISION	NO	NO	21	Y	M	-	6/18	-11.00/2.00x30
19	D	cases	44	M	694463	-	-	-	-	-	-	-	-	-
20	D	cases	12	M	759315	-	-	-	-	-	-	-	-	-
21	D	cases	29	M	237858	-	-	-	-	-	-	-	-	-
22	E	cases	16	M	641712	DECNEASL OF VISION	NO	-	15	Y	M	-	6/9	-
23	G	cases	25	M	741097	DECNEASL OF VISION B/E	NO	NO	24	NO	NO	6/18 (P)	6/9(P)	-
24	G	cases	29	F	495455	DIMINATION OF VISION	NO	NO	28	NO	NO	6/9(P)	-	-
25	G	cases	17	F	572963	DOV L/E	NO	NO	14	Y	M	6/24	-	-
26	G	cases	16	M	700999	DIMINATION OF VISION	NO	NO	16	NO	NO	6/6	6/6	-
27	G	cases	15	M	528085	DOV B/E	Y	3	13	NO	NO	6/6	-	-
28	G	cases	17	M	707152	DOV R/E *10	-	-	16	Y R/E	Y R/E	-	6/36	-
29	G	cases	21	M	777258	-	-	-	-	-	-	-	-	-
30	G	cases	16	F	591711	DECNEASL OF VISION L>R	NO	NO	15	NO	NO	6/9(P)	-	-

Sr. No	Name Initial	Examination							TOPOGRAPHY						
		CORNEA	FLEISHER'S RING	VOGT'S STRIAE	MUNSON'S SIGN	APICAL SCAR	SCISSORING REFLEX	FUNDUS	K1 (Flat keratometry)	K2 (Steep keratometry)	Kmax (keratometry at steepest point)	Astigmatism	Thinnest pachymetery	Pupil center pachymetery	Apex pachymetery
1	H	-	N	N	N	N	N	WNL	45.5	47.3	57.6	1.7	418	444	424
2	KT	-	Y	N	N	N	N	WNL	42	43.2	43.6	1.2	526	534	533
3	P	-	-	-	-	-	-	-	46.3	50.6	57	4.3	487	501	501
4	RK	-	-	-	-	-	-	-	48.6	51.9	55.9	3.4	415	431	419
5	Y	-	-	-	-	-	-	-	48.6	54.6	58.2	6	431	438	435
6	N	-	-	-	-	-	-	-	42.8	46	48.5	3.4	505	511	514
7	AS	-	-	-	-	-	-	-	43.9	44.5	49.2	0.7	472	485	484
8	AS	-	Y	Y	N	N	N	WNL	42.7	45.1	46.2	2.5	451	454	556
9	AK	-	-	-	-	-	-	-	46.8	52.2	59.2	5.5	478	492	489
10	A	-	-	-	-	-	-	-	40.7	42.3	43.5	1.6	475	479	481
11	A	-	-	-	-	-	-	-	44	44.9	45.3	0.9	470	480	483
12	AJ	-	N	N	N	N	N	WNL	43.2	43.9	45.3	0.7	506	509	509
13	A	-	-	-	-	-	-	-	44.2	46.4	47.8	2.3	416	422	421
14	B	-	-	-	-	-	-	-	67.3	64	80.6	1.8	279	337	306
15	BS	-	-	-	-	-	-	-	44.3	49.2	47.3	0.9	431	435	436
16	B	-	-	-	-	-	-	-	47.1	52.9	54.6	5.8	485	490	485
17	B	-	-	-	-	-	-	-	67.3	69	80.6	1.8	279	337	306
18	C	-	N	N	Y	N	N	MYOPIC DEGENENATION B/E	45	47.5	49.5	2.5	378	384	385
19	D	-	-	-	-	-	-	-	42.1	48.2	51.8	6.1	486	501	496
20	D	-	-	-	-	-	-	-	50.9	53	61.8	2	470	474	472
21	D	-	-	-	-	-	-	-	46.8	50.2	55.8	3.5	506	538	529
22	E	-	Y	N	Y	N	N	WNL	44	48.1	52.2	4.1	475	496	489
23	G	-	Y	Y	Y	N	Y	WNL	44.2	51.7	55	7.5	484	490	487
24	G	-	N	N	Y	N	N	WNL	45.7	51.4	57.3	5.7	468	490	480
25	G	-	N	N	N	N	N	WNL	40.1	47	48.9	6.9	436	443	440
26	G	-	N	N	N	N	N	WNL	43.5	44.3	44.7	0.8	545	549	549
27	G	-	Y	N	N	N	Y	WNL	41	48	51.2	7	458	563	465
28	G	-	Y	Y	Y	N	Y	NORMAL	54.8	59.5	64.6	4.7	412	437	416
29	G	-	-	-	-	-	-	-	43.1	44.2	45.4	1.1	498	501	503
30	G	-	Y	N	N	N	Y	WNL	46.2	50.5	56.9	4.3	462	482	482

		RIGHT EYE																		
						PACHYMETERY MAPS (ASOCT)														
								SN-IT asymmetry												(inferior superior asymm
Sr. No	Name Initial	ART (Ambrosio Relational Thickness)	D value (Standard deviation from mean)	FET	BET	Minimum Epithelial thickness	Min-Median (minimum epithelial thickness – maximum epithelial thickness)	2-5 mm	5-7 mm	7-9 mm	Central epithelial thickness	Thinnest corneal thickness	2-5 mm	5-7 mm	7-9 mm	K1 (Flat keratometry)	K2 (Steep keratometry)	Kmax (keratometry at steepest point)	Astigmatism	Thinnest pachymetery
1	H	134	9.66	25	48	33	-13	14	-1	-7	41	409	8	-6	-10	44.3	46.2	57.1	1.9	421
2	KT	329	1.88	2	11	35	-3	2	2	0	45	518	-2	-2	-4	42.7	44.9	47.8	2.2	522
3	P	172	5.44	10	22	29	-8	9	4	3	42	335	9	6	-	46.7	51.8	62.7	5.1	458
4	RK	132	10.62	25	56	31	-5	6	5	3	40	413	-1	-	-	43.6	46.1	50	2.5	446
5	Y	126	8.07	18	30	35	-10	14	6	-2	43	433	8	1	-	44.6	47.4	48.2	2.7	482
6	N	328	2.48	9	9	38	-9	8	7	0	54	492	6	0	-6	42.9	46.2	48.1	3.3	508
7	AS	240	3.63	8	19	-	-46	9	24	-	53	0	-	-	-	4.38	44.9	45.2	1.9	479
8	AS	322	2.73	7	14	34	-9	3	2	0	46	262	1	-5	-	45.1	53.7	56.1	8.5	413
9	AK	148	9.79	26	61	33	-11	6	-4	-8	36	0	2	-11	-16	44	44.5	47.8	0.5	525
10	A	282	3.15	6	16	41	-5	4	-3	0	54	438	6	2	-1	41.3	44	46.3	2.7	471
11	A	221	3.19	6	15	39	-6	5	-	-	51	0	-2	-7	-12	46.4	48.4	51.8	2	455
12	AJ	357	1.5	2	6	32	-3	3	-1	-2	46	0	1	-2	-	49.5	538	62.7	4.3	431
13	A	184	4.23	7	12	37	-6	5	1	-	53	412	0	-5	-	46.5	49.6	57.6	3.1	382
14	B	22	28.96	23	139	30	-21	7	6	-	67	0	21	17	-	42.9	44.9	47.8	2	462
15	BS	247	4.55	10	17	39	-3	3	2	-1	44	419	0	-3	-4	47.2	50	58.3	2.8	406
16	B	271	4.79	11	19	38	-4	-4	-4	-6	44	498	-6	-6	-5	57.2	62.4	65.8	5.3	388
17	B	22	28.96	23	139	30	-21	7	6	-	67	0	21	17	-	42.9	44.9	47.8	2	462
18	C	137	5.88	9	19	45	-10	-4	-3	-5	53	355	-6	2	-	45	50.5	55.7	5.5	390
19	D	221	5.64	16	40	40	-5	4	1	1	45	475	2	4	-	46.9	56.7	60.9	10.3	433
20	D	187	10.4	31	45	30	-9	7	3	-	51	363	0	-	-	46.4	48.1	50.7	1.7	485
21	D	143	7.61	21	48	-	-9	-11	8	-	41	493	6	2	-	44.7	47.2	50.3	2.5	537
22	E	178	4.94	11	27	35	-8	8	4	-3	46	342	4	-5	-	43.8	45.9	46	1.9	504
23	G	216	5.52	11	22	25	-5	6	4	8	42	471	6	-	-	43.6	45.3	45.9	1.7	527
24	G	165	8.44	3	5	28	-6	3	1	-	52	459	-3	-	-	43.5	74.5	50.3	3.8	487
25	G	244	4.72	14	21	32	-7	6	5	5	46	430	-1	0	-5	40	46.7	49	6.8	450
26	G	403	1.38	3	5	-	-4	0	-3	-1	48	530	-1	-2	-7	43.9	48.3	52.3	4.4	545
27	G	243	5.24	15	22	33	-6	-2	-4	-3	47	451	-3	-2	3	41.7	46.7	50	5.3	471
28	G	113	14.89	36	85	29	-35	-	-	-	40	0	-4	-6	-	42.7	43.7	44.2	0.9	511
29	G	304	2.65	5	9	40	-3	-2	0	-10	49	492	-1	-5	-12	43.2	56.4	55.9	7.2	486
30	G	157	7.82	24	51	-	-16	7	14	-	44	445	6	-	-	62.9	68.2	79.9	5.3	345

		LEFT EYE															
		TOPOGRAPHY						PACHYMETERY MAPS (ASOCT)									
		metery)								SN-IT asymmetry					(inferior		
Sr. No	Name Initial	Pupil center pachymetery	Apex pachymetery	ART (Ambrosio Relational Thickness)	D value (Standard deviation from mean)	FET	BET	Minimum Epithelial thickness	Min-Median (minimum epithelial thickness – maximum epithelial thickness)	2-5 mm	5-7 mm	7-9 mm	Central epithelial thickness	Thinnest corneal thickness	2-5 mm	5-7 mm	7-9 mm
1	H	454	431	119	10.96	30	60	32	-11	11	1	-7	44	413	4	-7	-8
2	KT	530	528	230	3.69	7	23	31	-5	1	1	-	46	503	4	-	-
3	P	571	464	189	7.81	20	33	35	-5	2	1	1	46	0	-3	0	-
4	RK	457	435	150	6.49	16	34	39	-7	11	2	0	52	449	6	5	3
5	Y	48	489	235	3.03	6	13	38	-5	3	1	1	48	474	-1	0	-1
6	N	512	513	422	2.36	13	13	37	-10	8	6	1	49	485	8	6	-1
7	AS	484	483	311	2.25	3	7	34	-10	-5	-6	-	53	0	-6	-7	-
8	AS	420	418	197	7.87	24	38	35	-17	-2	-5	-6	49	244	5	5	0
9	AK	539	543	174	4.2	8	29	38	-7	4	1	-	50	551	4	-4	-
10	A	483	482	195	4.94	11	29	31	-8	9	5	-1	53	461	10	3	-
11	A	467	466	193	7.4	18	37	39	-10	10	5	1	42	418	2	-1	-3
12	AJ	490	490	101	12.42	39	69	30	-14	12	4	-2	43	1	9	10	-
13	A	402	393	101	9.28	27	47	30	-17	20	4	-5	44	369	14	-3	-10
14	B	479	471	213	4.09	10	20	35	-11	6	11	8	60	465	5	16	-
15	BS	415	412	151	9.26	30	46	32	-9	11	12	14	39	217	3	1	-
16	B	421	401	83	12.04	7	54	34	-7	-4	-2	-6	39	405	-10	-10	-17
17	B	479	471	213	4.09	10	20	35	-11	6	11	8	60	465	5	16	-
18	C	393	392	115	8	15	28	39	-12	0	-	-	55	0	-9	-	-
19	D	448	443	162	6.76	8	13	30	-8	-2	-	-	45	383	-5	-	-
20	D	496	496	238	4.79	8	12	27	-5	2	-2	-2	41	12	-5	-11	-
21	D	556	555	214	3.98	14	30	35	-10	4	4	1	49	528	0	-5	-
22	E	506	508	365	1.25	2	2	24	-3	-2	2	-	49	467	0	-	-
23	G	531	529	415	0.58	0	1	30	-7	-4	-6	-	51	508	0	-	-
24	G	494	494	212	4.38	12	20	29	-8	8	3	-	41	1	4	-2	-
25	G	457	456	312	3.89	14	20	35	-6	3	-3	-	46	438	1	-5	-
26	G	547	547	291	3.89	12	20	29	-7	5	6	-	48	519	4	-2	-
27	G	475	475	263	4.68	12	22	32	-10	-4	-7	-7	47	343	-7	-6	-4
28	G	522	524	248	2.67	6	18	33	-3	0	-2	-	50	433	-2	-6	-
29	G	493	496	223	5.74	14	30	38	-5	-1	-3	-4	45	313	-7	-6	-8
30	G	407	375	42	21.59	25	78	27	-24	1	11	-	40	0	-15	-	-

Sr. No	Name Initial	Group	Age	Gender	MRD No	History								
						Chief Complaint	H/O VKC	AGE OF ONSET OF VKC	AGE OF KCN DIAGNOSIS	SPECTACLE H/O	FREQUENCY OF CHANGE OF GLASSES	UCVA (Un Corrected Visual Acuity)	BSCVA (Best Spectacle Corrected Visual Acuity)	CURRENT REFRACTION
31	H	cases	30	M	739283	DECNEASL OF VISION L>R	NO	NO	31	Y	M	6/18	6/6	-1.75/-1.75x616
32	H	cases	25	F	749418	DOV L/E	-	-	24	Y	M		6/6	-4.00/-0.75x15
33	H	cases	23	M	-	DIFFICULTY WITH GLASSES	NO	NO	21	Y	M	-	6/6	-0.50/-0.50x80
34	H	cases	17	M	531606	DOV R>L ITCHING RALNESS B/E	Y	10.11	16	Y	Y	-	-	-
35	IK	cases	25	F	761261	DOV R>L	-	-	-	-	-	-	6/36	-10.00/-3.50X180
36	J	cases	19	M	726498	-	-	-	-	-	-	-	-	-
37	J	cases	24	F	633095	-	-	-	-	-	-	-	-	-
38	JS	cases	17	M	539517	BURNING SEMATION,PHOTOPHOBIA,DEENEASL OF VISION	NO	-	15	Y	M	-	6/9	-0.5/-2.0X60
39	J	cases	13	M	516467	-	-	-	-	-	-	-	-	-
40	J	cases	25	F	286454	ITCHING B/E	Y	12	30	Y	M	6/24(P)	6/9	-
41	K	cases	36	F	553756	-	-	-	-	-	-	-	-	-
42	K	cases	16	M	601064	ITCHING,DOV B/E	Y	3	16	NO	NO	6/6	6/6	-
43	K	cases	16	F	567167	DOV R>L	-	-	15	-	-	-	6/9	-4.50X22
44	K	cases	13	F	654344	DOV B/E	Y	10	12	Y	NO	2/60	6/36(P)	-
45	K	cases	21	F	554162	DIFFICULTY WITH GLASSES	-	-	174	Y	M	-	6/6	-2.00/-0.75X140
46	K	cases	19	F	757498	-	-	-	-	-	-	-	-	-
47	K	cases	12	F	638744	DOV B/E	Y	9	11	Y	M	-	6/6	-0.25/-3.50x10
48	KV	cases	28	M	760618	-	-	-	-	-	-	-	-	-
49	KG	cases	46	M	495140	DIFFICULTY WITH GLASSES	-	-	-	Y	M	-	6/6(P)	+0.5/-6.25x83
50	K	cases	10	F	478500	DOV B/E	-	-	9	4 Y	Y	-	6/12	-6.00/-3.50x40
51	M	cases	19	M	744471	-	-	-	-	-	-	-	-	-
52	M	cases	33	M	50753	DOV B/E	-	-	28	Y	M	-	6/6	-2.25x90
53	M	cases	13	M	511962	DOV L/E	-	-	12	Y	Y.M	-	6/6	-3.50/-1.25x20
54	N	cases	14	F	750521	DOV B/E	-	-	14	NO	NO	6/36(P)	6/9	-3.25/-3.00x10
55	N	cases	31	M	161722	-	-	-	-	-	-	-	-	-
56	N	cases	29	F	308866	DIFFICULTY WITH GLASSES	-	-	26	Y	M	-	6/9	-2.75/-4.00x40
57	N	cases	22	M	76825	DOV L/E	-	-	20	Y	M	-	6/6	-1.75 DSs

Sr. No	Name Initial	Examination							TOPOGRAPHY						
		CORNEA	FLEISHER'S RING	VOGT'S STRIAE	MUNSON'S SIGN	APICAL SCAR	SCISSORING REFLEX	FUNDUS	K1 (Flat keratometry)	K2 (Steep keratometry)	Kmax (keratometry at steepest point)	Astigmatism	Thinnest pachymetery	Pupil center pachymetery	Apex pachymetery
31	H	N	N	N	N	N	N	WNL	45.7	49.3	52.8	3.7	411	418	417
32	H	-	N	N	N	N	N	NORMAL	44.5	45.7	47.4	1.2	503	507	506
33	H	-	Y	N	N	N	N	WNL	41.8	42.7	43.6	0.9	508	510	511
34	H	-	-	-	-	-	-	-	46.2	48.2	52.9	2	452	482	474
35	IK	-	Y	Y	N	N	Y	WNL	57.9	61.6	68.3	3.7	396	412	402
36	J	-	-	-	-	-	-	-	68.1	73.6	80.4	5.5	35.8	587	367
37	J	-	-	-	-	-	-	-	49.2	52.5	67.3	3.3	473	495	476
38	JS	Y	N	N	N	N	N	WNL	43.4	49.4	53.5	6	452	459	459
39	J	-	-	-	-	-	-	-	43.2	45.2	47.4	2	516	528	528
40	J	-	N	N	N	N	N	WNL	44.1	44.3	45.5	0.2	514	519	517
41	K	-	-	-	-	-	-	-	44.8	46.8	48.2	2	456	463	464
42	K	-	N	N	N	N	N	NORMAL	43.6	45.2	49.2	1.7	481	496	494
43	K	-	Y	N	N	N	N	NORMAL	44.3	49.6	53.8	5.3	510	518	515
44	K	-	Y	Y	Y	Y	Y	NORMAL	47.7	56	58.5	8.4	283	404	414
45	K	-	Y	Y	Y	N	N	NORMAL	44.3	45.4	48	1	490	497	496
46	K	-	-	-	-	-	-	-	44.9	47.7	51.9	2.8	487	497	493
47	K	-	-	-	-	-	-	WNL	44.3	47.8	50.2	3.5	521	535	539
48	KV	-	-	-	-	-	-	-	43.4	44.4	45.9	1.1	487	503	501
49	KG	-	Y	N	N	N	N	NORMAL	40.8	50.4	51.8	9.6	466	475	468
50	K	-	Y	N	N	N	N	NORMAL	45.5	48.3	53.2	2.8	483	491	489
51	M	-	-	-	-	-	-	-	47.2	50.1	55.4	2.9	471	478	475
52	M	-	-	-	-	-	-	WNL	41	43.1	48.7	2.1	530	539	536
53	M	-	Y	N	Y	N	N	NORMAL	46.3	49.4	55.4	3.1	476	478	478
54	N	-	Y	Y	Y	N	Y	NORMAL	47.5	50.3	55.5	2.9	441	450	446
55	N	-	-	-	-	-	-	-	44.9	47.4	53.9	2.5	443	456	445
56	N	-	N	N	N	N	N	NORMAL	46.2	49.1	51.9	2.8	345	370	357
57	N	-	N	N	N	N	N	WNL	41.6	42.8	44	1.2	460	464	464

		RIGHT EYE																		
						PACHYMETERY MAPS (ASOCT)														
								SN-IT asymmetry												(inferior superior asymm
Sr. No	Name Initial	ART (Ambrosio Relational Thickness)	D value (Standard deviation from mean)	FET	BET	Minimum Epithelial thickness	Min-Median (minimum epithelial thickness – maximum epithelial thickness)	2-5 mm	5-7 mm	7-9 mm	Central epithelial thickness	Thinnest corneal thickness	2-5 mm	5-7 mm	7-9 mm	K1 (Flat keratometry)	K2 (Steep keratometry)	Kmax (keratometry at steepest point)	Astigmatism	Thinnest pachymetery
31	H	134	6.5	12	31	24	-12	-1	0	8	45	396	-1	0	8	49.9	56.5	62.4	6.6	391
32	H	370	1.26	2	6	25	-6	-3	-3	0	48	478	-2	-2	-	48.6	50.6	64.2	2	432
33	H	209	3.01	6	14	39	-4	2	0	-3	48	394	-1	0	-2	45.9	49	53	3.1	464
34	H	139	7.41	21	47	34	-8	11	3	-3	45	449	6	0	0	43.4	44.8	48.7	1.3	477
35	IK	64	18.2	31	102	38	-7	6	8	-	45	360	6	-	-	48.5	50.3	54	1.8	483
36	J	50	22.74	50	115	38	-25	-27	-37	-	88	0	-15	-	-	54.6	71.7	75.3	17.1	316
37	J	141	11.8	32	68	35	-13	18	4	-12	41	458	13	-4	-12	44.7	48.7	60.5	3.9	489
38	JS	169	6.4	18	32	-	-9	5	2	2	46	322	-7	-14	-14	42.7	47	50.4	4.3	467
39	J	296	3.08	9	16	31	-6	3	-6	-	49	513	1	-	-	55	59	74	4	452
40	J	348	2.05	4	10	37	-6	2	4	5	54	504	-2	-2	-	44.8	46.3	50.2	1.5	496
41	K	152	4.62	6	26	33	-9	1	3	-	52	313	-1	-4	-	46.1	49.7	55.4	3.6	412
42	K	207	5.06	10	22	30	-10	2	0	1	58	390	-2	-7	-	46.1	51.9	58	5.7	458
43	K	298	3.7	11	21	38	-6	6	1	-1	52	463	3	0	0	44.9	47	5.6	2.1	518
44	K	0	4.88	-26	69	37	-8	-7	-2	-1	44	206	-1	1	-	46.8	51.2	55.8	4.4	253
45	K	241	5.98	12	33	35	-5	4	4	7	52	277	4	2	-	47.6	52	55.4	4.4	442
46	K	217	4.79	10	22	38	-9	7	3	-	48	354	4	-	-	45.3	52.2	59.6	7	469
47	K	109	4.2	-6	24	29	-10	-2	-1	-	51	0	-6	-	-	45.3	48.8	52.8	3.5	547
48	KV	183	4.02	7	22	41	-8	5	-	-	58	389	2	-	-	50.3	53.9	64.2	3.7	384
49	KG	241	5.11	8	27	36	-4	3	4	1	55	475	1	4	-	39.8	49.8	51.2	10	463
50	K	267	5.54	18	33	29	-4	0	7	12	39	471	3	6	10	44.2	46.5	52.2	1.8	490
51	M	184	7.66	19	38	30	-3	6	3	-	45	0	2	1	-	48.4	49.8	55.5	1.4	471
52	M	251	3.44	10	24	32	-12	-	13	7	-3	437	9	-3	-10	41.3	43.1	49.1	1.8	512
53	M	221	6.05	15	29	36	-8	0	-2	-	42	1	-7	-	-	54.8	56.7	71.7	1.9	441
54	N	208	7.43	20	37	40	-5	3	1	-6	46	440	3	3	-	49.2	54.4	59	5.2	435
55	N	126	8.11	15	29	32	-6	5	-2	-	36	442	3	-5	-	44.7	45.6	49.2	0.9	492
56	N	125	7.94	25	43	30	-12	9	-3	-	43	344	-	-	-	45.5	46.1	49.2	0.6	352
57	N	297	2.41	5	9	34	-5	1	-1	-7	54	451	-1	-5	-	44.2	51.6	60.2	7.4	421

		LEFT EYE															
		TOPOGRAPHY						PACHYMETERY MAPS (ASOCT)									
		metery)								SN-IT asymmetry					(inferior		
Sr. No	Name Initial	Pupil center pachymetery	Apex pachymetery	ART (Ambrosio Relational Thickness)	D value (Standard deviation from mean)	FET	BET	Minimum Epithelial thickness	Min-Median (minimum epithelial thickness – maximum epithelial thickness)	2-5 mm	5-7 mm	7-9 mm	Central epithelial thickness	Thinnest corneal thickness	2-5 mm	5-7 mm	7-9 mm
31	H	391	395	121	10.64	25	52	34	-8	3	1	-	40	381	1	-6	-14
32	H	477	441	114	11.89	32	64	30	-10	8	1	-	40	418	8	1	-
33	H	476	473	170	8.8	24	50	33	-9	8	1	5	42	250	-1	-5	-5
34	H	488	487	284	2.48	4	8	34	-4	1	-2	-4	44	490	-2	-5	-
35	IK	498	492	207	7.68	17	37	34	-9	6	1	-8	39	468	5	2	-
36	J	335	318	29	23.67	28	102	43	-24	4	22	-	79	0	9	-	-
37	J	515	498	130	9.3	27	62	38	-6	2	0	-3	56	0	2	-3	-
38	JS	468	468	240	4.5	11	19	32	-8	9	0	-5	48	426	-4	-12	-
39	J	460	477	106	15.39	43	85	34	-14	7	-1	-	38	445	10	-	-
40	J	516	510	172	4.98	12	31	41	-5	4	-	-	52	485	2	-3	-
41	K	425	421	109	7.36	10	35	26	-12	-7	-5	4	40	126	11	-1	-
42	K	473	464	170	8.8	23	48	35	-8	9	0	-8	45	463	4	-7	-14
43	K	527	526	325	2.3	3	11	33	-6	-2	-2	-3	52	519	-2	-7	-10
44	K	449	449	8	37.3	-52	60	34	-9	-6	-1	-4	43	393	-4	9	-
45	K	452	452	117	9.82	17	54	31	-10	-3	1	10	45	437	-6	-4	5
46	K	489	481	170	8.07	22	47	37	-5	1	-	-	44	0	1	-	-
47	K	556	557	404	1.3	5	4	25	-11	-8	-7	-	42	395	-6	-4	-
48	KV	423	392	78	15.14	32	87	30	-15	11	1	-1	33	1	-4	-	-
49	KG	476	469	222	4.42	6	25	35	-9	7	5	6	54	374	4	8	14
50	K	500	497	257	6.03	19	33	46	-16	11	2	-1	78	490	2	1	-
51	M	490	478	177	9.28	22	48	37	-8	8	-6	-	46	448	1	-2	-
52	M	539	535	195	5.81	42	48	30	-12	-	15	3	41	511	10	-3	-6
53	M	448	443	142	14.53	34	69	39	-13	4	-2	-5	41	420	-2	-4	-
54	N	442	438	172	8.96	23	43	37	-5	1	-1	-3	42	420	-3	-3	-
55	N	506	504	250	6.05	15	35	29	-9	3	-5	-6	37	494	-2	-10	-
56	N	377	367	131	6.99	17	34	27	-11	8	-3	-	47	308	-	-	-
57	N	434	428	163	9.23	25	46	37	-10	12	-1	-3	44	380	5	-5	-5

Sr. No	Name Initial	Group	Age	Gender	MRD No	History						UCVA (Un Corrected Visual Acuity)	BSCVA (Best Spectacle Corrected Visual Acuity)	CURRENT REFRACTION
						Chief Complaint	H/O VKC	AGE OF ONSET OF VKC	AGE OF KCN DIAGNOSIS	SPECTACLE H/O	FREQUENCY OF CHANGE OF GLASSES			
58	N	cases	17	M	680353	DIFFICULTY IN READING	-	-	16	NO	NO	6/12(P)	6/9	+0.5/-4.00X35
59	P	cases	29	M	459798	DOV R/E	-	-	24	Y	M	-	6/12(P)	-2.75/-4.50
60	P	cases	30	F	571495	-	-	-	-	-	-	-	-	-
61	P	cases	28	M	385119	DOV B/E	-	-	28	Y	M	-	6/9	-3.50/-8.00X35
62	P	cases	22	M	489610	-	-	-	-	-	-	-	-	-
63	P	cases	19	M	600914	DOV L/E	-	-	-	-	-	-	6/6	-2.00X60
64	P	cases	30	F	463861	DIFFICULTY WITH GLASSES	-	-	-	Y	NO	-	6/6	-1.00/-1.75X85
65	PR	cases	18	F	750508	DOV B/E	-	-	17	Y	M	-	6/12	-7.75/-4.00X45
66	P	cases	29	F	572162	-	-	-	-	-	-	-	-	-
67	P	cases	14	F	632329	-	-	-	-	-	-	-	-	-
68	R	cases	23	M	647449	DOV B/E	Y	17	21	Y	M	FC 3/60	6/12(P)	-6.00X60
69	RB	cases	25	M	551869	-	-	-	-	-	-	-	-	-
70	R	cases	51	M	692559	DOV B/E	Y	15	48	Y	M	-	6/6(P)	-1.25/-3.00X160 ADD +2.25 DS
71	R	cases	21	M	276698	DOV B/E	Y	15	20	Y	M	-	6/9	-1.00/-4.00X110
72	R	cases	22	F	646609	DOV B/E	N	N	22	Y	M	-	6/6	-
73	SB	cases	21	M	455426	ITCHING B/E	Y	14	19	Y	M	-	6/9	-9.5X40
74	S	cases	16	F	553344	DOV B/E	-	-	-	-	-	6/18	6/6(P)	-3.50X35
75	S	cases	19	M	507061	DOV B/E	Y	14	17	Y	M	-	6/6(P)	-1.50/-1.00X45
76	S	cases	36	M	553607	DOV B/E	N	N	35	Y	M	-	6/6	-1.25/-3.00X10
77	S	cases	28	F	672528	DOV R/E	-	-	27	Y	M	-	6/60	-3.00/-3.50X50
78	SA	cases	24	F	709194	-	-	-	-	-	-	-	-	-
79	S	cases	7	M	643104	-	-	-	-	-	-	-	-	-
80	SS	cases	16	M	254319	DOV B/E	Y	13	16	Y	M	-	6/6	-0.50/-5.50X30
81	A	cases	27	M	778745	-	-	-	-	-	-	-	-	-
82	BK	cases	30	F	658958	DOV B/E	-	-	28	Y	M	-	6/6	-6.00/-3.50X110
83	DM	cases	24	F	724180	-	-	-	-	-	-	-	-	-
84	GS	cases	22	M	638066	-	-	-	-	-	-	-	-	-
85	C	cases	21	F	188336	-	-	-	-	-	-	-	-	-
86	MK	cases	19	F	455730	-	-	-	-	-	-	-	-	-
87	M	cases	24	F	541129	DOV B/E	Y	12	23	N	N	-	FC (1M) Y 60	-
88	MS	cases	12	M	602175	-	-	-	-	-	-	-	-	-
89	M	cases	48	M	512531	-	-	-	-	-	-	-	-	-
90	S	cases	29	F	465883	-	-	-	-	-	-	-	6/6(p)	-
91	S	cases	28	F	130309	-	-	-	-	-	-	-	-	-
92	S	cases	18	F	735600	-	-	-	-	-	-	-	-	-
93	SS	cases	19	M	45095	-	-	-	-	-	-	-	-	-
94	T	cases	17	M	496173	-	-	-	-	-	-	-	-	-
95	J	cases	17	M	304903	-	-	-	-	-	-	-	-	-

Sr. No	Name Initial	Examination							TOPOGRAPHY						
		CORNEA	FLEISHER'S RING	VOGT'S STRIAE	MUNSON' S SIGN	APICAL SCAR	SCISSORING REFLEX	FUNDUS	K1 (Flat keratometry)	K2 (Steep keratometry)	Kmax (keratometry at steepest point)	Astigmatism	Thinnest pachymetery	Pupil center pachymetery	Apex pachymetery
58	N	-	Y	Y	Y	N	Y	-	45.6	51	56.6	5.5	491	496	499
59	P	-	Y	Y	Y	N	Y	WNL	47.5	50	57.5	4.5	418	465	438
60	P	-	-	-	-	-	-	-	43.1	47.4	50.7	4.3	429	440	440
61	P	-	Y	N	Y	N	Y	NORMAL	47.7	54	58.3	6.6	443	453	452
62	P	-	-	-	-	-	-	-	43.5	46.2	48.4	2.7	476	489	491
63	P	-	Y	N	N	N	N	NORMAL	44.3	46.3	52.2	2.2	456	461	460
64	P	-	N	N	N	N	N	NORMAL	43.8	45.3	45.7	1.5	551	558	558
65	PR	-	Y	N	Y	N	N	NORMAL	46	49.7	52.4	3.7	438	445	443
66	P	-	-	-	-	-	-	-	42.9	43.6	47	0.8	489	501	502
67	P	-	-	-	-	-	-	-	50.6	57.5	63.9	6.9	398	459	464
68	R	-	Y	Y	Y	N	Y	MYOFIC DEGENERATION	55.7	58.4	81	2.8	425	472	429
69	RB	-	-	-	-	-	-	-	44.3	47.8	56.5	3.5	477	502	481
70	R	-	Y	Y	Y	N	Y	WNL	45.6	50.7	54.5	5.1	594	514	503
71	R	-	Y	Y	N	N	N	WNL	44.6	51.9	58.2	7.4	465	470	468
72	R	-	N	N	N	N	N	WNL	43.2	45.1	46.4	2	452	467	46
73	SB	-	Y	Y	Y	N	Y	WNL	42.8	50	52.7	7.1	463	467	469
74	S	-	Y	N	N	N	N	WNL	45	48.3	52.1	3.3	487	499	497
75	S	-	Y	Y	Y	N	Y	WNL	44.7	47.5	57.6	2.8	455	473	465
76	S	-	N	Y	N	N	N	WNL	41.7	45.6	47.9	3.9	478	493	490
77	S	-	Y	Y	N	N	N	WNL	50.6	54	59.2	3.4	462	478	469
78	SA	-	-	-	-	-	-	-	49.3	53.9	59.4	4.7	455	470	457
79	S	-	-	-	-	-	-	-	47	51.9	52.1	4.4	462	470	470
80	SS	-	Y	N	N	N	N	WNL	43.1	49.5	52.9	6.3	478	487	483
81	A	-	-	-	-	-	-	-	44.7	48.1	53	3.4	463	500	491
82	BK	-	Y	N	N	N	Y	WNL	48.3	49.1	57.6	0.8	432	445	434
83	DM	-	-	-	-	-	-	-	51.8	52.7	62	0.9	434	461	450
84	GS	-	-	-	-	-	-	-	43.1	48.4	50.7	5.3	524	531	531
85	C	-	-	-	-	-	-	-	43	44	46.4	1	497	501	500
86	MK	-	-	-	-	-	-	-	45.4	46.8	48.4	1.4	475	481	482
87	M	-	N	N	Y	Y	N	WNL	59.4	65	72.1	5.6	304	31.4	304
88	MS	-	-	-	-	-	-	-	47.9	50.3	56.8	2.4	403	426	410
89	M	-	-	-	-	-	-	-	48	51.4	53.9	3.5	347	406	389
90	S	-	-	-	-	-	-	-	48.1	54.4	61.2	6.2	365	385	369
91	S	-	-	-	-	-	-	-	45.3	48.2	53.8	2.9	448	463	457
92	S	-	-	-	-	-	-	-	47.8	54	59.6	6.2	418	432	423
93	SS	-	-	-	-	-	-	-	42.7	48	49.7	5.4	491	494	497
94	T	-	-	-	-	-	-	-	45.8	47.2	52.5	1.4	471	477	473
95	J	-	-	-	-	-	-	-	45.3	49.7	54.8	4.4	416	421	418

		RIGHT EYE																		
						PACHYMETERY MAPS (ASOCT)														
								SN-IT asymmetry												(inferior superior asymm
Sr. No	Name Initial	ART (Ambrosio Relational Thickness)	D value (Standard deviation from mean)	FET	BET	Minimum Epithelial thickness	Min-Median (minimum epithelial thickness – maximum epithelial thickness)	2-5 mm	5-7 mm	7-9 mm	Central epithelial thickness	Thinnest corneal thickness	2-5 mm	5-7 mm	7-9 mm	K1 (Flat keratometry)	K2 (Steep keratometry)	Kmax (keratometry at steepest point)	Astigmatism	Thinnest pachymetery
58	N	197	7.54	19	43	30	-7	7	2	1	43	489	4	-4	-11	45.1	47.7	51.4	5.6	468
59	P	101	12.4	38	82	29	-12	21	7	-5	34	411	15	4	-8	42.4	47.8	54.1	5.4	444
60	P	106	7.64	10	44	35	-12	8	1	0	43	427	-	-4	-3	43.6	46.5	48.7	2.8	493
61	P	159	9.12	25	52	35	-5	3	5	2	42	438	1	3	-	45.1	47.1	47.5	2	487
62	P	195	5.15	13	35	36	-14	13	7	-	58	370	10	-	-	43.2	45.1	46.1	1.9	497
63	P	179	5.06	13	21	35	-8	0	-6	-7	56	336	-3	-13	-	48.4	53.7	61.9	5.3	406
64	P	343	1.39	0	11	28	-7	-8	-4	-	50	539	-1	-9	-	44.9	46.1	48.9	1.2	52.8
65	PR	212	6.76	17	32	35	-9	8	1	-3	47	441	1	-6	-6	47.2	51	54.5	3.8	454
66	P	202	4.61	12	21	34	-9	6	1	-	43	482	4	-3	-	44.7	48.9	54.1	4.2	475
67	P	0	4.3	60	46	34	-16	-6	-5	-6	55	429	10	8	-	49.1	55.9	71.4	6.8	232
68	R	73	16.53	43	88	34	-14	20	-	-	43	399	20	-4	-	63	64.4	88.7	1.4	409
69	RB	168	7.14	18	40	37	-9	13	6	1	44	1	11	1	-	42	42.8	49.4	0.8	506
70	R	184	7.73	18	51	39	-8	4	-3	-3	50	495	-1	-7	-8	47.8	53.3	58.8	5.4	453
71	R	262	7.05	15	26	31	-14	3	-1	-	39	312	-8	-	-	43.7	49.7	55.2	6	452
72	R	193	5.28	11	30	30	-10	7	-2	-6	53	434	-1	-13	-	44.1	45.7	47.7	1.6	440
73	SB	234	502	16	28	40	-5	1	-3	-5	53	456	-4	-7	-2	43.2	44.3	44.8	1	485
74	S	177	647	16	43	33	-13	10	1	-6	45	471	1	-8	-7	44.7	47.8	50.3	3.1	507
75	S	117	6.86	15	32	32	-14	13	7	-	52	418	10	-1	-	44.3	45.5	47.7	1.2	481
76	S	219	5.14	12	36	30	-8	11	-1	-8	61	490	4	-6	-12	42.8	44.4	46.4	1.6	48.6
77	S	155	10.36	27	56	38	-12	9	-8	-11	52	474	1	-18	-17	47	48.6	51.3	1.5	500
78	SA	166	9.36	22	43	25	-14	17	9	-3	44	456	11	-1	-	45.7	49.1	55	3.4	481
79	S	190	2.99	2	6	41	-3	1	1	-	46	479	-1	-	-	47.1	51.4	51.6	4.3	483
80	SS	231	5.94	17	32	-	-12	16	12	-56	41	461	11	10	5	42.3	47.1	49.4	4.8	494
81	A	156	8.42	36	71	34	-12	16	-	-	44	440	7	-	-	44.1	45.4	47.7	1.3	493
82	BK	450	10.6	26	49	41	-9	2	-5	-	44	189	4	-3	-	44.2	47.8	53.3	3.6	442
83	DM	87	11.91	17	40	32	-16	21	4	-4	37	423	11	-6	-	44.7	47.8	55.2	3.1	466
84	GS	350	3.32	11	21	32	-4	-2	-1	-6	44	509	-2	-	-	42.2	45.9	52.9	3.7	493
85	C	294	1.54	3	3	29	-6	0	1	2	48	485	-1	-3	-6	42.9	43.5	44.1	0.6	491
86	MK	227	3.73	6	13	30	-9	7	10	-	61	481	1	-3	-	59.2	65.6	77.3	6.4	376
87	M	33	22.15	6	5	-	-52	-4	-4	-	40	230	-13	20	-	55.3	62.9	66.9	7.6	371
88	MS	177	8.24	25	41	32	-148	47	-	-	43	210	12	-	-	-	-	-	-	-
89	M	45	10.39	2	34	22	-331	3	1	-	71	266	-	-	-	48.7	51.6	55.7	2.9	395
90	S	126	5.31	2	12	-	-11	-7	-4	-	51	315	-10	-	-	48	54.4	62.6	6.4	367
91	S	176	5.28	15	28	11	-9	9	3	-6	49	442	6	-2	-6	45.5	49	54.3	3.5	443
92	S	146	11.04	29	53	36	-103	5	6	-	42	423	3	-	-	52.5	56.2	58.3	3.7	398
93	SS	241	5.11	14	30	39	-8	4	-3	-4	47	477	-6	-10	-	42.5	43.7	44.7	1.1	507
94	T	215	7.74	20	37	35	-10	11	11	12	48	443	13	9	8	46.4	52.7	59.5	6.3	437
95	J	152	7.02	18	32	41	-8	6	4	-	51	344	7	-1	-	44.3	44.9	47	0.5	443

Sr. No	Name Initial	LEFT EYE																
		TOPOGRAPHY						PACHYMETERY MAPS (ASOCT)										
		metery)								SN-IT asymmetry					(inferior			
		Pupil center pachymetery	Apex pachymetery	ART (Ambrosio Relational Thickness)	D value (Standard deviation from mean)	FET	BET	Minimum Epithelial thickness	Min-Median (minimum epithelial thickness – maximum epithelial thickness)	2-5 mm	5-7 mm	7-9 mm	Central epithelial thickness	Thinnest corneal thickness	2-5 mm	5-7 mm	7-9 mm
58	N	498	499	176	5.84	11	35	28	-6	5	-2	-7	42	481	5	-6	-
59	P	475	460	151	8.36	29	59	28	-14	14	4	-2	42	428	7	-3	-8
60	P	495	496	304	2.47	5	8	35	-4	-3	-2	-2	43	477	-6	-8	-7
61	P	492	495	238	4.01	8	21	28	-6	2	-1	-4	44	378	-1	-6	-
62	P	507	507	254	3.69	7	23	40	-6	4	1	0	49	482	-1	-5	-6
63	P	425	421	105	11.59	30	65	27	-7	5	-6	-10	40	192	5	2	4
64	P	543	538	269	4.54	10	31	41	-9	8	-	-	54	0	7	6	-
65	PR	464	461	174	7.68	21	41	-	-16	9	-24	-	45	421	-8	-143	-445
66	P	494	489	175	6.88	147	27	37	-10	9	-3	-	47	338	2	-	-
67	P	270	291	14	22.92	-6	75	37	-13	-1	3	3	40	191	-3	-3	-
68	R	462	430	57	18.22	31	85	39	-15	6	-	-	45	382	22	-	-
69	RB	528	518	199	4.08	9	24	38	-7	-1	3	2	53	494	8	2	-3
70	R	473	463	124	11.86	25	72	-	-13	-2	-17	-	41	415	-2	-2	-
71	R	460	460	174	5.66	5	15	34	-9	7	-	-	43	441	-3	2	-
72	R	456	454	163	6.15	15	36	34	-13	11	-1	-6	47	426	3	-7	-13
73	SB	486	488	386	1.04	2	2	40	-6	-5	-5	-	53	474	-10	-9	-10
74	S	517	517	230	4.6	11	31	-	-9	5	-7	49	45	491	-3	-7	-9
75	S	487	487	225	4.01	6	19	-	-7	6	-3	-	46	270	3	-6	-
76	S	500	498	208	5.14	9	34	38	-6	5	-1	-4	50	486	5	-7	-
77	S	518	516	176	5.63	12	34	36	-13	15	6	0	47	493	9	-1	-7
78	SA	501	491	142	7.32	14	35	34	-9	12	4	-	44	334	6	-7	-
79	S	490	488	236	3.77	7	13	41	-3	0	-1	-	44	389	-2	-3	-
80	SS	501	499	251	3.96	12	23	34	-10	9	2	0	43	481	4	-1	-3
81	A	508	507	234	4.18	12	27	32	-13	12	12	-	50	472	6	-	-
82	BK	449	446	154	6.89	18	35	-	-5	-2	-4	-	42	432	-2	-	-
83	DM	498	489	155	8.64	32	59	31	-14	13	-1	-5	40	0	0	-5	-8
84	GS	507	530	139	5.34	-18	25	24	-6	2	-3	-	52	504	5	7	-
85	C	497	494	328	1.5	2	2	27	-3	1	2	1	47	486	-1	-2	-9
86	MK	391	378	60	21.26	53	112	37	-11	12	5	-	44	0	1	4	-
87	M	425	381	74	15.07	28	80	41	-6	-7	0	-11	49	0	-2	2	-1
88	MS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
89	M	438	421	70	9.53	5	29	29	-428	-7	0	-	65	379	-16	-9	-
90	S	405	393	82	6.55	-1	18	29	-21	-10	-	-	53	1	-19	-	-
91	S	467	462	131	6.85	18	42	32	-9	8	-	-	56	436	7	-1	-7
92	S	408	405	104	12.22	24	61	23	-345	1	6	-	45	0	2	-	-
93	SS	511	512	263	2.6	3	9	35	-4	2	-1	-5	48	494	-4	-8	-
94	T	473	457	122	10.82	27	62	26	-9	-4	-1	-	41	387	3	-	-
95	J	455	455	159	4.8	6	31	42	-4	2	-1	-	51	375	3	-2	-

Sr. No	Name Initial	Group	Age	Gender	MRD No	History								
						Chief Complaint	H/O VKC	AGE OF ONSET OF VKC	AGE OF KCN DIAGNOSIS	SPECTACLE H/O	FREQUENCY OF CHANGE OF GLASSES	UCVA (Un Corrected Visual Acuity)	BSCVA (Best Spectacle Corrected Visual Acuity)	CURRENT REFRACTION
96	Y	cases	27	M	491268	-	-	-	-	-	-	-	-	-
97	R	cases	21	M	784716	-	-	-	-	-	-	-	-	-
98	KS	cases	25	M	367507	BLURRING OF VISION,ROUTINE CHECKUP.	-	-	-	-	-	6/36(P)	-	-
99	T	cases	29	M	819697	-	-	-	-	-	-	-	-	-
100	S	cases	24	F	841231	-	-	-	-	-	-	-	-	-
101	S	cases	39	F	821718	-	-	-	-	-	-	-	-	-
102	N	cases	21	F	851753	-	-	-	-	-	-	-	6/6	-4
103	D	cases	11	M	820944	-	-	-	-	-	-	-	-	-
104	G	cases	32	M	807786	-	-	-	-	-	-	6/6	-	-
1	AM	controls	21	M	Volunteer	-	-	-	-	-	-	-	6/6	-2.00/-2.50x11
2	AC	controls	22	F	Volunteer	-	-	-	-	-	-	-	6/6	-2.00/-2.5x11
3	AG	controls	20	F	Volunteer	-	-	-	-	-	-	-	6/6	-0.50x160
4	AP	controls	21	F	Volunteer	-	-	-	-	-	-	-	6/6	-4.50 DS
5	AJ	controls	22	M	Volunteer	-	-	-	-	-	-	-	6/6	-2.00/-1.50X108
6	A	controls	22	F	Volunteer	-	-	-	-	-	-	-	6/6	-0.50 DS
7	AK	controls	22	F	Volunteer	-	-	-	-	-	-	-	6/6	-3.25 DS
8	BA	controls	22	F	Volunteer	-	-	-	-	-	-	6/6	-	-
9	BS	controls	21	M	Volunteer	-	-	-	-	-	-	6/6	-	-
10	AK	controls	21	M	Volunteer	-	-	-	-	-	-	-	6/6	-5.25 DS
11	AB	controls	21	M	Volunteer	-	-	-	-	-	-	-	6/6	-1.50X180
12	AS	controls	21	M	Volunteer	-	-	-	-	-	-	-	6/6	-3.00/-1.50X170
13	AG	controls	21	M	Volunteer	-	-	-	-	-	-	-	6/6	-1.25 DS
14	AG	controls	21	M	Volunteer	-	-	-	-	-	-	-	6/6	-1.00 DS
15	AS	controls	22	M	Volunteer	-	-	-	-	-	-	-	6/6	-1.50 DS
16	A	controls	22	M	Volunteer	-	-	-	-	-	-	-	6/6	-6.00 DS
17	AR	controls	23	F	Volunteer	-	-	-	-	-	-	6/6	-	-
18	R	controls	21	F	Volunteer	-	-	-	-	-	-	-	6/6	-1.00X180
19	A	controls	21	F	Volunteer	-	-	-	-	-	-	-	6/6	-0.25/-0.50X10
20	V	controls	22	F	Volunteer	-	-	-	-	-	-	-	6/6	-1.00 DS
21	V	controls	22	F	Volunteer	-	-	-	-	-	-	-	6/6	-0.25/-0.25X180
22	SM	controls	22	M	Volunteer	-	-	-	-	-	-	6/6	-	-
23	GK	controls	21	F	Volunteer	-	-	-	-	-	-	-	6/6	-1.50/-0.50X180
24	GK	controls	22	F	Volunteer	-	-	-	-	-	-	6/6	-	-
25	HS	controls	24	M	Volunteer	-	-	-	-	-	-	-	6/6	-0.75/-0.25X60
26	EG	controls	21	M	Volunteer	-	-	-	-	-	-	-	6/6	-0.50/-0.25X180
27	S	controls	24	M	Volunteer	-	-	-	-	-	-	6/6	-	-
28	AS	controls	21	M	Volunteer	-	-	-	-	-	-	-	6/6	-6.25/-1.25X25
29	AG	controls	27	F	Volunteer	-	-	-	-	-	-	6/6	-	-

Sr. No	Name Initial	Examination							TOPOGRAPHY						
		CORNEA	FLEISHER'S RING	VOGT'S STRIAE	MUNSON'S SIGN	APICAL SCAR	SCISSORING REFLEX	FUNDUS	K1 (Flat keratometry)	K2 (Steep keratometry)	Kmax (keratometry at steepest point)	Astigmatism	Thinnest pachymetery	Pupil center pachymetery	Apex pachymetery
96	Y	-	-	-	-	-	-	-	43	45	47	2	463	459	461
97	R	-	-	-	-	-	-	-	45.1	45.8	48.7	0.7	416	427	425
98	KS	-	-	-	+	-	-	-	43.6	47	51	3.4	458	478	471
99	T	-	-	-	-	-	-	-	44.4	45.8	46.4	1.4	540	547	550
100	S	-	-	-	-	-	-	-	47.4	52.2	60.1	4.8	466	477	470
101	S	-	-	-	-	-	-	-	48.2	50.3	53.3	2.2	471	483	480
102	N	-	-	-	-	-	-	-	49.7	53.6	59.1	4	440	445	444
103	D	-	-	-	-	-	-	-	64.9	69.3	87.8	4.5	414	453	421
104	G	-	-	-	-	-	-	-	46.7	48.9	55.2	2.2	472	487	474
1	AM	-	-	-	-	-	-	-	41.2	44.2	45.1	2.9	533	534	534
2	AC	-	-	-	-	-	-	-	43.3	43.8	44.2	0.5	537	538	539
3	AG	-	-	-	-	-	-	-	41.6	42.5	42.7	0.9	564	567	568
4	AP	-	-	-	-	-	-	-	45.5	46.5	46.9	1	519	521	520
5	AJ	-	-	-	-	-	-	-	43.1	44.4	44.8	1.4	520	524	525
6	A	-	-	-	-	-	-	-	43.6	44.1	445	0.5	257	530	531
7	AK	-	-	-	-	-	-	-	41.3	42.4	42.8	1.1	495	496	497
8	BA	-	-	-	-	-	-	-	42.9	44.5	45.2	1.6	519	522	524
9	BS	-	-	-	-	-	-	-	41.4	42.3	42.7	0.9	504	506	506
10	AK	-	-	-	-	-	-	-	43.5	45	45.3	1.5	552	559	559
11	AB	-	-	-	-	-	-	-	43.1	45.5	45.7	2.4	566	570	570
12	AS	-	-	-	-	-	-	-	42.9	43.3	43.6	0.5	563	567	569
13	AG	-	-	-	-	-	-	-	40.1	40.7	41.1	0.6	512	517	518
14	AG	-	-	-	-	-	-	-	43.4	43.8	45	0.4	544	546	547
15	AS	-	-	-	-	-	-	-	40.2	40.7	14	0.5	574	580	580
16	A	-	-	-	-	-	-	-	41.2	41.5	42.1	0.4	551	551	552
17	AR	-	-	-	-	-	-	-	42.2	43.5	43.9	1.3	551	556	557
18	R	-	-	-	-	-	-	-	43.5	45.7	46.4	2.2	513	517	516
19	A	-	-	-	-	-	-	-	42.7	43.9	44.5	1.2	560	560	561
20	V	-	-	-	-	-	-	-	43.9	44.5	44.9	0.6	495	500	499
21	V	-	-	-	-	-	-	-	43.8	44.7	45	1	514	517	516
22	SM	-	-	-	-	-	-	-	43.7	44.5	45.7	0.9	515	517	517
23	GK	-	-	-	-	-	-	-	43.5	45	45.1	1.5	502	504	505
24	GK	-	-	-	-	-	-	-	43.1	44.1	44.4	0.9	550	553	554
25	HS	-	-	-	-	-	-	-	44.5	45	45.6	0.6	553	555	556
26	EG	-	-	-	-	-	-	-	42	42.8	43.4	0.8	525	526	527
27	S	-	-	-	-	-	-	-	44.8	45.7	46.1	0.9	521	525	527
28	AS	-	-	-	-	-	-	-	39.5	40.7	41.3	1.2	486	489	489
29	AG	-	-	-	-	-	-	-	44.4	44.9	45.7	0.5	583	587	590

		RIGHT EYE																		
						PACHYMETERY MAPS (ASOCT)														
								SN-IT asymmetry												(inferior superior asymm
Sr. No	Name Initial	ART (Ambrosio Relational Thickness)	D value (Standard deviation from mean)	FET	BET	Minimum Epithelial thickness	Min-Median (minimum epithelial thickness – maximum epithelial thickness)	2-5 mm	5-7 mm	7-9 mm	Central epithelial thickness	Thinnest corneal thickness	2-5 mm	5-7 mm	7-9 mm	K1 (Flat keratometry)	K2 (Steep keratometry)	Kmax (keratometry at steepest point)	Astigmatism	Thinnest pachymetery
96	Y	174	3.75	5	16	36	-6	0	0	-5	41	451	-6	-9	-4	43.7	44.5	45.9	0.9	463
97	R	159	5.98	12	27	31	-5	6	2	-1	40	408	4	-4	-4	48	48.7	56	0.8	402
98	KS	177	6.76	20	42	28	-9	12	3	-4	40	452	11	0	-12	42.1	43.6	47.3	1.5	493
99	T	253	3.97	6	29	23	-4	1	-	-	42	489	-5	-13	-	43	46	46.6	3	555
100	S	171	7.39	19	39	33	-11	11	-	-	47	446	8	-	-	49.2	53.4	60.9	4.2	459
101	S	154	4	14	41	29	-13	11	5	8	41	453	0	-	-	53.2	55.8	60	2.6	457
102	N	178	8	18	31	21	-11	-1	-	-	42	387	-7	-4	-	50.2	53.8	58.9	3.7	448
103	D	64	23.54	55	99	30	-10	3	-	-	35	228	3	-	-	43.8	46.1	49.8	2.3	521
104	G	220	5.73	12	27	34	-7	1	-2	-	44	461	4	1	-	45.8	49.5	58.9	3.7	439
1	AM	344	1.41	4	0	37	-3	-1	-	-1	51	467	-3	-	-	-	-	-	-	-
2	AC	495	0.39	2	1	27	-6	-4	-	-	50	484	-5	-10	-	43.4	43.8	44.3	0.4	538
3	AG	550	0.04	2	2	37	-4	-1	-	-	51	486	-2	-5	-	41.8	42.3	42.7	0.5	573
4	AP	378	1.75	3	3	24	-10	0	-3	-	58	513	-3	-	-	45.4	46.1	46.4	0.8	519
5	AJ	322	1.62	2	6	33	-2	-1	-	-	50	514	-3	-5	-	43.5	44.3	44.5	0.8	528
6	A	400	1.26	1	7	40	-9	0	-	-	64	521	-9	-	-	43.3	43.6	44.3	0.2	533
7	AK	351	0.84	2	1	19	-4	-1	-	-	46	479	-3	-6	-	41.2	42.1	42.8	0.9	5.4
8	BA	365	1.43	3	8	19	-6	-2	-	-	53	505	-2	-5	-	42.7	44.3	44.4	1.6	515
9	BS	437	0.87	3	3	34	-4	1	-	-	51	495	-2	-5	-	41.6	42	42.4	0.4	505
10	AK	395	1.31	2	6	34	-8	-1	-1	-8	52	550	-3	-5	-3	43.4	44.4	44.6	1	559
11	AB	492	1.12	6	11	33	-4	1	-	-	45	552	-1	-7	-	43.7	44.2	44.5	0.4	567
12	AS	481	0.94	3	6	33	-5	-3	-	-	52	433	-3	-5	-	42.6	43.7	44.7	1.1	585
13	AG	366	0.91	1	-1	39	-3	1	1	-	56	445	2	1	-	39.7	40.1	40.3	0.4	507
14	AG	425	1.39	5	5	34	-4	-2	-	-	53	421	0	0	-	43.8	44.1	44.8	0.3	544
15	AS	494	0.09	2	4	33	-3	0	1	-	49	562	-2	-1	-	40.2	40.9	41.2	0.7	578
16	A	389	0.58	1	2	28	-4	-3	-	-	46	544	-5	-	-	40.7	41.8	42.2	1.2	555
17	AR	373	1.23	1	5	43	-3	2	-	-	50	542	3	-	-	42.5	43.6	43.9	1.1	555
18	R	311	1.95	3	11	29	-6	-2	-	-	50	318	-4	-7	-	44.3	45.5	46.6	2.2	509
19	A	477	1	3	6	32	-7	-7	3	-	48	345	6	6	-	42.8	43.5	44	0.8	554
20	V	330	1.51	3	4	32	-4	0	0	-1	46	481	1	-3	-	44	44.6	44.9	0.6	492
21	V	329	1.08	1	1	37	-1	2	-	-	49	476	1	-	-	43.9	44.8	45.2	0.9	516
22	SM	316	1.53	2	2	36	-5	3	-	-	51	505	-1	-7	-	43.9	45	46.5	1.1	517
23	GK	376	2.3	4	7	1	-5	0	-	-	48	480	-11	-	-	43.6	44.7	44.9	1.1	498
24	GK	388	1.22	2	6	32	-4	4	-	-	46	532	1	0	-2	43.4	43.9	44.3	0.6	553
25	HS	416	1.89	6	10	28	-55	-7	-	-	65	527	-	-	-	44.2	44.7	45.4	0.5	541
26	EG	482	0.67	2	3	32	-7	4	-	-	54	518	3	-5	-	42.1	42.6	43.4	0.5	534
27	S	315	1.85	2	4	38	-4	3	1	-	49	509	0	0	-	44.5	45.5	46.1	0.9	521
28	AS	418	0.82	3	4	37	-7	2	8	-	57	473	0	-	-	39.6	41.1	41.4	1.6	494
29	AG	444	1.1	0	8	33	-5	4	-	-	49	575	4	4	-	44.5	44.9	45.4	0.3	579

		LEFT EYE															
		TOPOGRAPHY						PACHYMETERY MAPS (ASOCT)									
		metery)								SN-IT asymmetry					(inferior		
Sr. No	Name Initial	Pupil center pachymetery	Apex pachymetery	ART (Ambrosio Relational Thickness)	D value (Standard deviation from mean)	FET	BET	Minimum Epithelial thickness	Min-Median (minimum epithelial thickness – maximum epithelial thickness)	2-5 mm	5-7 mm	7-9 mm	Central epithelial thickness	Thinnest corneal thickness	2-5 mm	5-7 mm	7-9 mm
96	Y	465	466	3.18	3.18	6	12	38	-7	1	-2	-3	41	449	-10	-8	-1
97	R	420	408	106	9.71	20	46	33	-9	9	5	2	43	381	2	4	-
98	KS	509	508	214	4.38	11	28	20	-9	7	5	-2	47	475	8	0	-12
99	T	562	564	296	2.82	2	21	25	-6	3	-1	-4	41	405	-2	-7	-
100	S	470	462	152	8.48	19	45	35	-9	7	6	8	47	439	9	-	-
101	S	472	465	125	11.97	30	67	29	-18	13	-2	-4	36	426	5	-	-
102	N	454	450	204	8.28	-	-	34	-9	-1	-4	-9	41	435	-8	-8	-
103	D	524	535	234	2.59	4	11	27	-5	2	-5	-8	41	384	1	-11	-18
104	G	490	449	180	9.94	31	56	30	-12	12	2	1	44	344	14	12	-
1	AM	-	-	-	-	-	-	40	-6	-1	-3	-	55	386	-3	-6	-
2	AC	540	540	366	0.69	1	2	32	-5	-3	-3	-5	56	438	-4	-9	-19
3	AG	578	579	448	0.33	1	4	36	-8	2	-2	-3	56	489	-1	-8	-
4	AP	526	524	360	1.84	4	5	35	-6	2	0	0	51	506	1	-	-
5	AJ	532	533	324	1.48	3	3	31	-4	-2	-4	-3	49	339	-4	-	-
6	A	537	537	409	0.97	1	5	35	-50	-4	-	-	58	517	-	-	-
7	AK	505	505	422	0.59	2	-2	35	-4	-2	-2	-3	44	486	-2	-	-
8	BA	520	521	344	1.5	3	7	39	-5	1	-1	-4	52	509	-2	-5	-
9	BS	507	507	398	0.99	2	2	37	-3	-1	-2	-1	51	494	-3	-6	-
10	AK	562	561	400	1.16	2	6	29	-9	0	-1	-	51	548	-5	-10	-
11	AB	571	570	498	0.96	5	8	36	-4	2	0	-1	44	527	-1	-	-
12	AS	587	583	481	0.52	1	-3	38	-4	-2	-5	-8	52	541	-3	-4	-
13	AG	512	514	401	0.68	1	0	43	-4	1	0	-1	55	416	-1	-6	-
14	AG	548	549	423	1.31	5	5	32	-4	2	1	0	50	434	2	-1	-
15	AS	583	582	440	0.23	2	6	29	-4	1	-2	-4	49	567	-1	-	-
16	A	555	555	462	0.33	2	1	29	-4	-1	-3	-	45	540	-2	-3	-
17	AR	559	559	393	1.08	2	3	34	-3	0	-1	2	52	517	-1	-	-
18	R	517	516	311	2.08	1	11	31	-4	1	1	-	50	500	0	-	-
19	A	555	556	487	1.1	3	7	29	-4	-1	-2	-1	46	477	-2	-	-
20	V	497	492	318	1.83	3	4	28	-3	-1	2	0	52	486	-2	-3	-
21	V	520	518	336	1.2	2	2	35	-2	1	1	-3	49	406	0	-3	-
22	SM	521	523	319	1.66	2	3	32	-6	2	-4	-7	51	433	0	-	-
23	GK	499	500	316	2.16	4	6	-	-7	2	-8	-32	48	484	1	-	-
24	GK	556	558	354	1.04	2	4	36	-4	2	-1	-1	47	533	1	-	-
25	HS	546	548	353	1.66	4	5	25	-16	5	-	-	62	518	1	-	-
26	EG	535	537	479	0.6	1	4	34	-5	1	0	1	52	450	2	-2	-
27	S	529	532	292	2.14	3	8	41	-4	1	1	1	47	513	-2	-	-
28	AS	495	495	513	0.25	3	-1	39	-5	0	0	1	51	432	0	-	-
29	AG	585	587	443	1.21	1	10	31	-3	3	1	-2	46	563	2	0	-

Sr. No	Name Initial	Group	Age	Gender	MRD No	History								
						Chief Complaint	H/O VKC	AGE OF ONSET OF VKC	AGE OF KCN DIAGNOSIS	SPECTACLE H/O	FREQUENCY OF CHANGE OF GLASSES	UCVA (Un Corrected Visual Acuity)	BSCVA (Best Spectacle Corrected Visual Acuity)	CURRENT REFRACTION
30	AK	controls	20	F	Volunteer	-	-	-	-	-	-	6/6	-	-
31	SK	controls	21	F	Volunteer	-	-	-	-	-	-	-	6/6	-0.5/-1.50X90
32	H	controls	19	M	Volunteer	-	-	-	-	-	-	-	6/6	-2.00 DS
33	A	controls	19	F	Volunteer	-	-	-	-	-	-	6/6	-	-
34	C	controls	19	F	Volunteer	-	-	-	-	-	-	-	6/6	-4.00 DS
35	A	controls	23	M	Volunteer	-	-	-	-	-	-	6/6	-	-
36	GS	controls	23	M	Volunteer	-	-	-	-	-	-	6/6	-	-
37	M	controls	23	F	Volunteer	-	-	-	-	-	-	-	6/6	-1.50/-0.50X180
38	P	controls	21	F	Volunteer	-	-	-	-	-	-	6/6	-	-
39	N	controls	20	M	Volunteer	-	-	-	-	-	-	6/6	-	-
40	P	controls	19	F	Volunteer	-	-	-	-	-	-	6/6	-	-
41	P	controls	21	F	Volunteer	-	-	-	-	-	-	6/6	-	-
42	HK	controls	21	F	Volunteer	-	-	-	-	-	-	6/6	-	-
43	P	controls	21	M	Volunteer	-	-	-	-	-	-	6/6	-	-
44	R	controls	21	M	Volunteer	-	-	-	-	-	-	6/6	-	-
45	TB	controls	21	F	Volunteer	-	-	-	-	-	-	-	-	-4.00 DSPH
46	A	controls	21	F	Volunteer	-	-	-	-	-	-	6/6	-	-
47	CKG	controls	27	F	Volunteer	-	-	-	-	-	-	6/6	-	-
48	S	controls	-	F	Volunteer	-	-	-	-	-	-	-	-	-
49	AK	controls	22	M	Volunteer	-	-	-	-	-	-	6/6	-	-
50	AM	controls	21	F	Volunteer	-	-	-	-	-	-	-	-	-
51	UK	controls	20	F	Volunteer	-	-	-	-	-	-	-	-	-1.25/-0.50X174
52	SPS	controls	22	M	Volunteer	-	-	-	-	-	-	-	6/6	-1.50/-0.75X165
53	G	controls	21	M	Volunteer	-	-	-	-	-	-	-	-	-
54	TG	controls	19	M	Volunteer	-	-	-	-	-	-	-	-	-0.75 DSP
55	VK	controls	21	F	Volunteer	-	-	-	-	-	-	-	-	-2.25 DSP
56	YS	controls	19	M	Volunteer	-	-	-	-	-	-	-	-	-2.25DSP

Sr. No	Name Initial	Examination							TOPOGRAPHY						
		CORNEA	FLEISHER'S RING	VOGT'S STRIAE	MUNSON'S SIGN	APICAL SCAR	SCISSORING REFLEX	FUNDUS	K1 (Flat keratometry)	K2 (Steep keratometry)	Kmax (keratometry at steepest point)	Astigmatism	Thinnest pachymetery	Pupil center pachymetery	Apex pachymetery
30	AK	-	-	-	-	-	-	-	44.4	45.5	45.7	1.1	586	590	589
31	SK	-	-	-	-	-	-	-	41.8	42.9	43.4	1.1	565	568	568
32	H	-	-	-	-	-	-	-	41.3	41.6	42.3	0.3	496	499	496
33	A	-	-	-	-	-	-	-	42.6	43.8	44.4	1.2	531	533	533
34	C	-	-	-	-	-	-	-	45.6	46.7	47	1.1	522	526	527
35	A	-	-	-	-	-	-	-	43.5	43.7	44.7	0.2	519	523	523
36	GS	-	-	-	-	-	-	-	43.1	43.6	44.3	0.4	522	527	530
37	M	-	-	-	-	-	-	-	43.4	43.8	44	0.4	455	460	462
38	P	-	-	-	-	-	-	-	44.4	45.3	45.6	0.9	576	574	574
39	N	-	-	-	-	-	-	-	44.3	44.8	45.4	0.5	539	541	542
40	P	-	-	-	-	-	-	-	43.7	44.8	45.3	1	547	550	549
41	P	-	-	-	-	-	-	-	43	43.6	44.3	0.6	459	482	478
42	HK	-	-	-	-	-	-	-	43.9	45.3	45.7	1.4	613	616	616
43	P	-	-	-	-	-	-	-	45.9	46.1	46.7	0.3	566	569	568
44	R	-	-	-	-	-	-	-	44.6	45	45.6	0.4	530	532	534
45	TB	-	-	-	-	-	-	-	43.1	43.2	43.6	0.1	565	570	570
46	A	-	-	-	-	-	-	-	43.4	44.3	44.9	0.9	517	524	527
47	CKG	-	-	-	-	-	-	-	42.2	42.8	43.1	0.6	541	546	547
48	S	-	-	-	-	-	-	-	46.6	49.8	52.3	3.3	492	501	499
49	AK	-	-	-	-	-	-	-	43.5	45	45.3	1.5	557	559	559
50	AM	-	-	-	-	-	-	-	41.2	44.2	45.1	2.9	533	534	534
51	UK	-	-	-	-	-	-	-	45.5	47.1	47.4	1.5	570	571	573
52	SPS	-	-	-	-	-	-	-	41.8	42.5	42.8	0.7	560	564	564
53	G	-	-	-	-	-	-	-	41.5	43	43.8	1.5	585	592	596
54	TG	-	-	-	-	-	-	-	42.3	42.9	44.8	0.6	574	575	575
55	VK	-	-	-	-	-	-	-	42.9	44.7	45	1.8	546	550	550
56	YS	-	-	-	-	-	-	-	43	43.6	43.8	0.6	549	553	554

		RIGHT EYE																		
						PACHYMETERY MAPS (ASOCT)														
								SN-IT asymmetry					(inferior superior asymm							
Sr. No	Name Initial	ART (Ambrosio Relational Thickness)	D value (Standard deviation from mean)	FET	BET	Minimum Epithelial thickness	Min-Median (minimum epithelial thickness – maximum epithelial thickness)	2-5 mm	5-7 mm	7-9 mm	Central epithelial thickness	Thinnest corneal thickness	2-5 mm	5-7 mm	7-9 mm	K1 (Flat keratometry)	K2 (Steep keratometry)	Kmax (keratometry at steepest point)	Astigmatism	Thinnest pachymetery
30	AK	400	0.83	2	3	35	-1	0	4	-	52	585	-1	-2	-	44.5	45.5	45.8	1	582
31	SK	422	0.57	1	2	30	-5	-2	-	-	50	551	-4	-	-	42.2	42.8	43	0.6	560
32	H	338	0.73	1	1	36	-8	4	-	-	50	486	1	-	-	41.5	41.7	42.2	0.2	506
33	A	392	0.51	0	2	32	-6	0	-	-	54	516	-4	-	-	43	44.4	44.8	1.4	536
34	C	378	1.56	4	8	32	-5	1	-	-	49	512	-3	-	-	45.4	46.7	47	1.2	529
35	A	430	0.68	0	0	33	-6	-4	-	-	54	476	-7	-	-	43.3	43.8	44.6	0.4	510
36	GS	406	0.92	2	4	44	-4	-1	-	-	53	527	-2	-	-	43.1	43.1	43.5	0.1	535
37	M	276	2.11	4	8	40	-5	1	7	19	45	444	-1	3	-	43.9	44.2	44.7	0.3	452
38	P	452	0.93	2	2	33	-5	-2	-5	-	50	554	-3	-8	-	44.1	45	46.2	0.9	575
39	N	419	0.82	1	-1	30	-4	-2	-	-	44	520	-3	-	-	44.3	45.1	46	0.8	542
40	P	343	1.63	4	5	34	-9	-6	-	-	52	535	-7	-	-	44.1	44.9	45.5	0.8	545
41	P	234	1.94	2	9	32	-7	1	-	-	50	527	-2	-	-	42.7	43.6	43.9	1	550
42	HK	437	1.54	6	12	32	-4	2	-	-	49	597	0	-1	-	43.6	45.3	45.7	1.7	615
43	P	460	0.77	2	6	36	-4	1	-	-	55	435	-2	-5	-	45	46.1	47.3	1.1	564
44	R	398	1.21	4	4	23	-5	-1	-	-	49	519	-2	-1	-	44.6	44.8	45.4	0.2	527
45	TB	477	0.48	2	4	42	-3	3	1	-3	45	549	-1	0	-	-	-	-	-	-
46	A	358	1.42	2	7	33	-4	1	-1	-4	50	500	2	-4	-7	43.4	44.4	45.2	0.9	531
47	CKG	406	1.16	3	9	38	-12	-5	-7	-	65	500	-5	-8	-	42.2	42.9	43.4	0.7	545
48	S	225	4.68	12	24	35	-4	2	0	-1	42	477	-3	-4	-	46.2	48.7	51.1	2.5	509
49	AK	395	1.31	2	6	34	-8	-1	-1	-8	52	550	-3	-5	-3	43.4	44.4	44.6	1	559
50	AM	344	1.41	4	0	37	-3	-1	1	-	51	467	-3	-	-	-	-	-	-	-
51	UK	392	2.23	5	4	41	-5	1	-	-	51	560	-3	-	-	46	47.6	48.7	1.6	565
52	SPS	489	0.29	2	0	35	-4	1	1	-1	53	596	0	-	-	42.2	42.9	43.3	0.7	566
53	G	397	0.59	-3	0	36	-6	1	18	-8	49	573	2	-	-	41.8	43.2	44	1.5	587
54	TG	637	-0.3	1	-2	28	-4	-1	0	3	48	555	-3	-5	-	42.1	42.9	44.6	0.7	568
55	VK	454	0.97	3	6	33	-4	1	3	-	48	0	0	-2	-	42.7	44.3	44.8	1.6	554
56	YS	467	0.69	1	4	37	-5	2	2	0	50	55	0	-4	-	43.3	44.1	44.3	0.8	534

		LEFT EYE															
		TOPOGRAPHY						PACHYMETERY MAPS (ASOCT)									
		metery)								SN-IT asymmetry					(inferior		
Sr. No	Name Initial	Pupil center pachymetery	Apex pachymetery	ART (Ambrosio Relational Thickness)	D value (Standard deviation from mean)	FET	BET	Minimum Epithelial thickness	Min-Median (minimum epithelial thickness – maximum epithelial thickness)	2-5 mm	5-7 mm	7-9 mm	Central epithelial thickness	Thinnest corneal thickness	2-5 mm	5-7 mm	7-9 mm
30	AK	588	588	376	0.8	1	1	34	-4	-1	-4	-4	51	574	-3	-	-
31	SK	567	566	412	0.63	2	1	33	-6	2	4	-	54	554	6	-5	-
32	H	508	507	345	1.02	1	1	38	-4	-2	-3	-	50	462	-2	-	-
33	A	538	539	466	0.88	2	5	40	-6	-	-14	-	51	517	-2	-	-
34	C	532	532	357	1.43	2	5	31	-5	1	-1	-	49	515	0	-	-
35	A	513	514	481	0.36	2	0	36	-13	0	-7	-17	57	453	-4	-	-
36	GS	538	538	411	0.78	3	3	38	-5	-2	-3	-	50	531	-8	-	-
37	M	457	460	272	2.19	3	7	38	-4	-2	2	-	48	329	1	3	4
38	P	582	583	398	1.06	1	5	38	-6	-2	-3	-	53	559	-4	-12	-
39	N	545	545	485	0.69	4	0	25	-4	-3	-	-	48	472	-5	-	-
40	P	549	549	388	1.73	5	6	39	-12	0	9	-	53	536	-2	-	-
41	P	555	557	424	1.1	3	5	31	-6	-1	-7	-	-48	483	-1	-	-
42	HK	619	620	481	0.84	3	3	32	-4	0	-1	-	49	486	-2	-	-
43	P	567	566	462	0.59	0	3	37	-6	-2	-4	-7	55	548	-2	-3	-
44	R	528	530	430	0.81	2	0	30	-6	-3	-1	-	47	482	-3	-5	-
45	TB	-	-	-	-	-	-	40	-3	1	-3	-	48	557	1	0	-3
46	A	537	539	396	1.43	2	8	28	-5	0	-4	-7	51	498	-2	-7	-10
47	CKG	546	547	450	1.17	2	6	21	-8	-2	5	-	58	523	-6	-4	-28
48	S	517	517	290	3.31	8	16	35	-4	-1	-1	-	42	498	-5	-5	-
49	AK	562	561	406	1.16	2	6	37	-9	0	-1	-	51	548	-5	-10	-
50	AM	-	-	-	-	-	-	40	-6	-1	-3	-	55	499	-3	-6	-
51	UK	570	571	407	2.33	6	12	35	-5	0	-	-	48	563	-2	-	-
52	SPS	567	568	451	0.47	2	2	33	-7	2	-	-	54	598	2	-	-
53	G	594	600	440	0.67	1	3	38	-5	5	-	-	52	580	1	-3	-
54	TG	570	571	488	0.17	1	2	31	-3	0	2	-	49	553	-2	-3	-
55	VK	558	558	457	1.04	3	6	16	-7	0	-	-	51	522	-4	-7	-
56	YS	542	542	421	1.11	2	7	35	-2	-2	2	-	51	526	-1	0	-

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Date 12/12/18

The Principal,
DMC, Ludhiana.

Subject: Approval of Plan of Thesis.

This is to inform you that the Faculty of Medical Sciences in its meeting held on 31.08.2018 has approved the plan of thesis of Amitoj Singh, a student of your college for MS Ophthalmology along with the names of Supervisor/Co-Supervisor as under :-

Topic Plan of Thesis
To evaluate the diagnosis efficacy of corneal epithelial thickness using spectrum domain optical coherence topography (sdoct) in keratoconus

Supervisor	Co-Supervisor
Dr. Sumeet Chopra	Dr. Gurkirat Singh Bajwa
Assoc. Prof.,	Prof. & Head,
Dept. of Ophthalmology,	Dept. of Ophthalmology,
DMCH, Ludhiana.	DMCH, Ludhiana..

The student may submit the four copies of thesis, to the Controller of Examinations, BFUHS, Faridkot, at least six months before the commencement of theory examination, if he/she is otherwise eligible to take the examination. He /She may be directed to attach a photocopy of this letter with the forwarding letter while submitting thesis in the University along with the letter of approval of University for change of supervisor/Co-Supervisor, change of topic, if any.

Dr S P Singh MS(Oph)
Controller of Examinations

Note :

1. *If any discrepancy found regarding topic of thesis or Supervisor/Co-Supervisor, inform undersigned within one month after issue of this letter.*
2. *The student may submit the thesis as per the schedule already conveyed i.e. for May/June examination 30th Nov of the preceding the year of examination and for Nov/Dec examinations 31st May of the year of examination.*

53.

4/58-2017

TO EVALUATE THE DIAGNOSTIC EFFICACY OF CORNEAL EPITHELIAL THICKNESS USING SPECTRUM DOMAIN OPTICAL COHERENCE TOPOGRAPHY (SDOCT) IN KERATOCONUS

THESIS PROPOSAL

FOR APPROVAL OF SUBJECT OF THESIS TO BE SUBMITTED
IN PARTIAL FULFILMENT OF THE REQUIREMENTS

FOR THE DEGREE OF

M.S

in

OPHTHALMOLOGY

OF THE

BABA FARID UNIVERSITY OF HEALTH SCIENCES
FARIDKOT

JANUARY, 2018

DR. AMITOJ SINGH

DEPARTMENT OF OPHTHALMOLOGY
DAYANAND MEDICAL COLLEGE AND HOSPITAL
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ABSTRACT OF PLAN OF THESIS

Title	TO EVALUATE THE DIAGNOSTIC EFFICACY OF CORNEAL EPITHELIAL THICKNESS USING SPECTRUM DOMAIN OPTICAL COHERENCE TOPOGRAPHY (SDOCT) IN KERATOCONUS
For the degree of	P.G. in Ophthalmology
Name of the candidate	Dr. Amitoj Singh
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Co-supervisor	Dr. Gurkirat Singh Bajwa, Professor & Head, Department of Ophthalmology, DMC&H, Ludhiana
Institution	Dayanand Medical College & Hospital, Ludhiana
University	Baba Farid University of Health Sciences, Faridkot

Introduction: Keratoconus was first described in 1854, derived from greek words kerato (cornea) and konus (cone). It is non inflammatory disease characterised by progressive corneal thinning and apical protusion. Its most common primary ectasia, estimated prevalence in general population is 54 per 100000. It is asymmetric and bilateral in 90% patients.

Aim of Study: To evaluate the usefulness of corneal epithelial thickness profile using spectral domain optical coherence tomography (SDOCT) in keratonus.

Materials & Methods: This study is aimed at proving the diagnostic efficacy of anterior segment OCT in keratoconus and forme fruste kertoconus.

Clinical Significance: Unrecognized early stage keratoconus is the leading cause of iatrogenic ectasia after laser in situ keratomileusis(LASIK) and remains major challenge of preoperative refractive surgery screening the early detection of keratoconus could assist in decision making, such as when assessing the need for early intervention with corneal collagen crosslinking treatments.

Keywords: keratoconus, forme fruste keratoconus, corneal ectasia, LASIK

(Signature)	(Signature)	(Signature)	(Signature)
Candidate	Co-supervisor	Supervisor	Principal

CERTIFICATE OF FACILITIES AVAILABLE

This is to certify that the facilities for work on the subject of thesis titled **"TO EVALUATE THE DIAGNOSTIC EFFICACY OF CORNEAL EPITHELIAL THICKNESS USING SPECTRUM DOMAIN OPTICAL COHERENCE TOPOGRAPHY (SDOCT) IN KERATOCONUS"** exist in the Department of Ophthalmology, DMC&H, Ludhiana and will be provided to the candidate. We will see that the data being included in the thesis is genuine and is collected by the candidate herself under our supervision and guidance.

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APPROVAL PROFORMA
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Date of enrollment	31st May, 2017
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2. HOD Surgery	2. HOD Pathology
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5. Dean Academics	5. HOD Medicine
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Research Committee

Chairperson
Research Committee

Approved: Yes / No

Chairperson
Ethics Committee

Chairperson
Ethics Committee

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4	DATE OF ADMISSION OF COURSE	31/05/2017
5	TITLE OF THE TOPIC	TO EVALUATE THE DIAGNOSTIC EFFICACY OF CORNEAL EPITHELIAL THICKNESS USING SPECTRUM DOMAIN OPTICAL COHERENCE TOPOGRAPHY (SDOCT) IN KERATOCONUS

6. BRIEF RESUME OF THE INTENDED WORK

6.1 NEED FOR THE STUDY

Human corneal epithelium covers the surface of cornea, where it protects the eye and plays an important role in maintaining high optical quality.[1]

Keratoconus was first described in 1854, derived from greek words kerato (cornea) and konus (cone). It is non inflammatory disease characterized by progressive corneal thinning and apical protusion. Its most common primary ectasia, estimated prevalence in general population is 54 per 100000.[2]

It is asymmetric and bilateral in 90% patients. Corneal degeneration is characterised by localised corneal thinning which leads to protusion of thinned cornea. Corneal thinning occurs normally occurs in the inferior-temporal as well as central cornea.[2]

Corneal protusion causes high myopia and irregular astigmatism, affecting the visual quality. It usually become apparent during second decade of life(normally during puberty). It typically progresses until the fourth decade of life after which it usually stabilizes.[2]

Clinical diagnosis of moderate to advanced keratoconus is not difficult because of characterstic topographic pattern and classical signs. However diagnosing early keratoconus in patients with normal BSCVA and minimal or no clinical signs can be challenging.

Early keratoconus diagnosis is especially important in preoperative screening for laser refractive surgeries because undetected corneal ectactic disorders can result in accelerated, progressive keratoectasia and unpredictable outcomes after LASIK and photorefractive keratectomy.

Form fruste keratoconus is subclinical disease not a variant of keratoconus. Terms like "mild keratoconus", "early keratoconus", "subclinical keratoconus" are not universaly accepted. It is known that forme fruste keratoconus is an incomplete, abortive or unusual form of disease, with topographic features that are insufficient for inclusion of those corneas in a keratoconus suspicious category. Contralateral corneas of patients with unilateral keratoconus, and it is important to evaluate these eyes carefully as the condition might progress.[3]

Diagnosis of keratoconus is clinical on the other hand diagnosis of form fruste keratoconus is topographic. There are no specific laboratory tests or numbers generated by diagnostic instruments that can make the diagnosis.

Unrecognized early stage keratoconus is the leading cause of iatrogenic ectasia after laser in situ keratomileusis(LASIK) and remains major challenge of preoperative refractive surgery screening.[4]

Haque et al reported that the central epithelial thickness in individuals with keratoconus was 4.7 micron thinner than the control thickness.[5]

Reinstein et al found that the central epithelial thickness in keratoconic eyes, 45.7+/-5.9 micron was significantly thinner than in normal eyes.[6]

Histopathologic analysis of corneal ectasia have shown thinning of the epithelium, usually overlying the steepest portion of the cornea, breaks in Descemet's membrane, fragmentation of Bowman layer, and scarring. The corneal epithelium has a rapid cell turnover and is highly reactive to asymmetries in the shape of the underlying stromal surface. Epithelial layer remodeling may therefore have a significant impact in corneal topographic

measurements, corneal warpage patterns, and early detection of corneal ectatic processes.[7]

The incidence of progressive corneal ectasia after LASIK has been estimated to be 0.2% (Rad et al., 2004).[8] Current theories suggest that the two main causes of post-LASIK ectasia are preexisting corneal pathology (keratoconus or forme fruste keratoconus), mechanical instability produced by the weakening of the residual corneal stromal bed induced by the flap creation, the effect of laser ablation, and probably eye rubbing. Careful pre-operative assessment of the cornea can greatly reduce the risk of ectasia, although it may occur in previously healthy and unsuspected corneas.

Moreover, the early detection of keratoconus could assist in decision making, such as when assessing the need for early intervention with corneal collagen crosslinking treatments. Corneal topography is currently the gold standard to evaluate ectatic corneal disorders such as keratoconus and pellucid marginal degeneration (PMD).[4]

Clinicians report eyes with normal topography and no other known risk factors that still develop post LASIK kerectasia.

It is likely that corneal topography does not capture all cases at risk. More recently, researchers have found that the corneal epithelium remodels in response to underlying stromal irregularities. Therefore, analysing the corneal epithelium and stroma separately might provide additional information for the diagnosis of keratoconus.

6.2 REVIEW OF LITERATURE

Yan li et al [1] conducted a study to map the corneal epithelial thickness with Fourier- domain optic coherence tomography (optic) and to develop epithelial thickness-based variables for keratoconus detection on one hundred forty-five eye from 76 Normal subject and 35 keretoconic eye from 22 patients. A 26 000-HZ Fourier- domain Oct system with 5 micron axial resolution was used. The corneal was imaged with a pachymetry+cpwr scan pattern (6-mm scan diameter,8 radials, 1024 axial-scans each, repeated 5 time) centered on the pupil. Three scan were obtained at a single visit in prospective study. A computer algorithm was developed to map the corneal epithelial thickness automatically. Zonal epithelial thickness and 5 diagnostic variable, including minimum, superior-inferior(S-I), minimum- maximum, map standard deviation (MSD) and pattern standard deviation (PSD), were calculated. Repeatability of the measurement (MIN-Max), map standard assessed by the pooled standard deviation. The area under the receiver operation characteristic curve(AUC) was used to evaluation diagnostic accuracy. The central, superior, and inferior epithelial thickness averages were 52.3+\- 3.6 micron ,49.6+\-3.5 micron and 51.2+\-3.4 micron in normal eye and 51.9+\-5.3 micron 51.2+\-4.2 micron and 49.1+\-4.3 mocron in keratoconic eye. Compared with normal eye, keretoconic eye had significantly lower inferior (P= 0.03) and minimum (P<0.0001) corneal epithelial thickness, greater S-I (P=0.013), more negative MIM-MAX (P<0.0001), greater MSD (P<0.0001), and larger PSD(P<0.00001). The repeatability of MSD was better than 0.4 micron. The repeatability of PSD was 0.02 or better. Among all epithelial thickness-based variables investigated, PSD provided the best diagnostic power (AUC=1.00).

using a PSD cutoff value of 0.057 alone gave 100% specificity and sensitivity. High-resolution Fourier-domain OCT mapped corneal epithelial thickness with good repeatability in both normal and keratoconic eye. Keratoconus was characterized by apical epithelial thinning. The resulting deviation fom the epithelial pattern could be detected with very high accuracy using the PSD variable.

Karolinne maria rocha, MD, PhD et al conducted study To assess corneal microarchitecture and region epithelial thickness profile in eyes with keretoconus, postoperative corneal ectasia, and normal unoperated eyes using spectral-domain optical coherence tomography (SD OCT). Regional corneal epithelial thickness Profiles of eyes with keratoconus and postoperative corneal ectasia were measured with anterior segment SC OCT (optovue RTVue-100, optovue Inc., Fremont, CA) and compared retrospectively to those of normal eyes (control). Epithelial thickness was assessed at 21 point, 0.5 mm apart, across the central 6-mm of the cornel apex in the horizontal and meridians. one hundred twenty eyes were evaluated, including 49 eyes from 29 patients with KC, 32 eyes from 16 patient with Ectasia, and 39 eyes from 21 control patients. Average epithelial thickness at the corneal apex was 41.8+\-6.47micron (range 30 to 51) in eyes with KC, 46.5+\-6.72 micron in eyes with ectasia (range 34 to 60 micron) and 50.45=\-3.92 micron in the eyes (range 42 to 55 micron). Apical epithelial thickness was significantly thinner in eyes with KC (p<.0001) and ectasia (p=.0007) than it was in controls. Epithelial thickness range in all other areas varied widely for KC (SD, range 21 to 101 micron) and actasia (SD, range 30 to 82 micron) compared to controls (SD, range 43 to 64),p=.0063. Central

epithelial thickness was, on average, significantly thinner in ectasic corneas compared to control; however, both central and regional epithelial thickness was highly irregular and variable in corneas with keratoconus and postoperative corneal ectasia. These thickness variations may alter preoperative topographic features and measurements in unpredictable ways, especially steepest K values. Regional epithelial thickness cannot be assumed to be unifrom in ectatic corneas and therefore may require direct measurement whe considering treatment for which stromal thickness is particularly important, such as corneal collagen cross-linking or topography-guided laser ablation.

Yan li et al conducted study to screen for subclinical keretoconus by analyzing corneal, epithelial, and stromal thickness map patterns with Fouies- domain optical coherence tomography (OCT). Eyes of normal subjects, subclinical keratoconus eyes, and the topographically normal eye of a unilateral keratoconus patient were studied. Corneal were scanned using a 26000 Hz Fouries-domain OCT system(RTVue). Normal subjects were divided into training and evaluation groups. Corneal, epithelial, and stromal thickness maps and derived diagnostic including pattern standard deviation (PSD) variables and pachymetery map based. Keretoconus risk scores were calculate from the OCT data. Area under the receiver operating characteristic curve (AUC) analysis was used to evaluated the diagnostic accuracy of the indices. The study comprised 150 eyes of 83 normal subjects, 50 subclinical keratoconus eyes of 32 patients, and 1 tomography normal eye of a unilateral keratoconus patient. Subclinical keratoconus was characterized by inferotemporal thinning of the cornea, epithelium and stroma. The PSD values

for corneal (p<.001), epithelial (p<.001), and stromal (p=.049) thickness maps were all significantly higher in subclinical keratoconus eyes than in the normal group. The diagnostic accuracy was significantly higher for PSD variables (pachymetric PSD,AUC=0.941; epithelial PSD,AUC=0.985; stromal PSD,AUC=0,924) than pachymetric map-based keratoconus risk score (AUC=0,735). High- resolution Fourier-domain OCT could map corneal, epithelial, and stromal thickness. Corneal and sub layer thickness changes in subclinical keratoconus could be detection with high accuracy using PSD variables. These new diagnostic variables might be useful in the detection of early keratoconus.

Shinichi fukuda et al conducted a study to evaluation the ability of parameters measured by three- dimension (3D) corneal and anterior segment optical coherence tomography (CAS-OCT) and a rotating scheimpflug camera combined with a placido topography system (scheimpflug camera with topography) to discriminate between normal eyes and from fruste keratoconus. Forty- eight of 48 patients with keratoconus, 25 eyes of 25 patient with from fruste keretoconus and 128 normal subjects were evaluated. Anterior and posterior keratometric. Parameter (steep K, flat K, average K), evelvation, topographic parameters, regular and irregular and irregular astigmatism (spherical, asymmetry, regular and higher order astigmatism) and five pachymetric parameter (minimum, minimum- median, inferior-superior , inferotemporal- superonasal , vertical thin newest location of the corneal) were measurement using 3D CAS-OCY and a scheimpflug camera with topography. The area under the receiver operation curve (AUROC) calculated to assess the discrimination ability. Compatibilty and repeatability

of both devices were evaluation. Posterior surface elevation showed higher AUROC value in discrimination analysis of frome fruste keratoconus using both devices. Both instrument showed significant linear correlation ($p<0.05$, pearson's correlation coefficient) and good repeatability (LCCs: 0.885- 0.999) for normal from fruste keretoconus. Posterior elevation was the best discrimination parameter for from fruste keretoconus. Both instrument presented good correlation and repeatability for this condition.

6.3 AIMS AND OBJECTIVES OF THE STUDY

- To evaluate the usefulness of corneal epithelial thickness profile using spectral domain optical coherence tomography (SDOCT) in keratonus.
- To find some reliable and definite parametres from corneal pachymetery maps that can help in early diagnosis of keratoconus.

7. MATERIALS AND METHODS

This study is aimed at proving the diagnostic efficacy of anterior segment OCT in keratoconus and forme fruste kertoconus.

7.1 SOURCE OF DATA

It's a cross sectional observational study, subjects were recruited from department of ophthalmology at dayanand medical college and hospital from january 2018 to june 2019.

7.2 METHOD OF COLLECTION OF DATA

Three groups will b formulated GROUP A comprising of NORMAL SUBJECTS, recruited from volunteers, patients seeking refractive surgery consultation. All having normal slit lamp findings and normal topographic features.

GROUP B comprising of KERATOCONUS.

B. Inclusion Criteria:

Keratoconic eyes included in the study were diagnosed on the basis of clinical evaluation and tomography. Each had corrected visual aquity of 20/25 or worse and had at least 1 clinical sign other than the keratoconic appearance of topography map (asymmetric bow-tie with skewed radial axis, central or inferior steep zone or claw shape). Keratoconic slit lamp finding included munson's sign, vogt's striae, Fleischer's ring, apical scar, apical thinning and scissoring reflex on retinoscopy.

C. Exclusion Criteria:

- Previous ocular surgery/trauma
- Associated corneal pathologic features (scaring, hydrops)
- History of collagen crosslinking

- Intrastromal corneal ring segment
- Keratoplasty/ other corneal surgery
- Contact lens wear during the previous 3 weeks

GROUP C comprising of FORME FRUSTE KERATOCONUS.

Subclinical keratoconic eyes with no slit lamp findings, BCVA of 20/20 or better, topographical normal eye of unilateral keratoconus. Exclusion criteria was same as that for keratoconus

Optical coherence tomography (OCT) is an optical acquisition method to examine biological tissues. In recent years, OCT has become an important imaging technology used in diagnosing and following macular pathologies. Further development enabled application of optical coherence tomography in evaluation of the integrity of the nerve fiber layer, optic nerve cupping, anterior chamber angle, or corneal topography.

Optical coherence tomography (OCT) systems use low-coherence, near-infrared light to provide detailed images of anterior segment structures at resolutions exceeding other systems like ultrasound biomicroscopy or conventional ultrasound. The Cirrus spectral-domain equipment (Carl Zeiss Meditec, Dublin, CA, USA) is an around 5 micra high-definition (HD) 840 nm spectral-domain OCT instrument primarily designed for retinal imaging.

The HD-OCT device has been recently used as a noninvasive corneal imaging modality that was capable of in vivo differentiation of both corneal layers and demonstration of pathologic abnormalities in the cornea. Corneal indications for the Cirrus OCT can be divided into pachymetry analysis, keratectomy, refractive surgery, structural, and contact lens abnormalities. For pachymetry, the Anterior Segment Cube 5 1 2 × 1 2 8enables identification of

the central corneal section, which facilitates positioning for central corneal thickness measurements.

OCT Imaging	Model 5000
Methodology	Spectral domain OCT
Optical Source	Superluminescent diode (SLD), 840 nm
Scan speed	27,000-68,000 A-scans per second
A-scan depth	2.0 mm (in tissue), 1024 points
Axial resolution	5 µm (in tissue)
Transverse resolution	15 µm (in tissue)

OUTCOME

Sensitivity and specificity of pachimetry maps in corneal epithelial thickness profile and its role in early diagnosis of keratoconus and forme fruste keratoconus.

STATISTICAL ANALYSIS

The data collected will be recorded in a pro forma and will be analysed using appropriate observational statistical methods.

7.3 DOES THE STUDY REQUIRE ANY INVESTIGATIONS OR INTERVENTIONS TO BE CONDUCTED ON PATIENTS OR OTHER HUMANS OR ANIMALS? IF SO, PLEASE DESCRIBE BRIEFLY.

-Anterior segment Optical Coherence tomography.

7.4 HAS THE ETHICAL CLEARANCE BEEN OBTAINED FROM ETHICAL COMMITTEE OF YOUR INSTITUTION IN CASE OF 7.3?

YES.

8. LIST OF REFERENCES

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8. Rad AS, Jabbarvand M, Saifi N. Progressive keratectasia after laser in situ keratomileusis. J Refract Surg. 2004;20(5 Suppl):S718-22.

PROFORMA

Sr. No. ___

NAME

AGE/SEX

MRD

ADDRESS

HISTORY

CHIEF COMPLAINT

H/O VKC

AGE OF ONSET OF VKC

SPECTACLE H/O

FREQUENCY OF CHANGE OF GLASSES

CURRENT REFRACTION

AGE OF KCN DIAGNOSIS

EXAMINATION

	Right eye	Left eye
UCVA		
BCVA(RGP)		
BCSVA		
CORNEA:		
FLEISHER'S RING		
VOGT'S STRIAE		
MUNSON'S SIGN		
APICAL SCAR		
SCISSORING'S REFLEX		
FUNDUS		
K READING		
TOPOGRAPHY		
PACHYMETERY MAPS (ASOCT)		

Signature of Candidate **Signature of supervisor**

INFORMED PATIENT CONSENT

Date: _____

I.....D/o, W/o, S/o.....

.....am willing to participate in the study **"TO EVALUATE THE DIAGNOSTIC EFFICACY OF CORNEAL EPITHELIAL THICKNESS USING SPECTRUM DOMAIN OPTICAL COHERENCE TOPOGRAPHY (SDOCT) IN KERATOCONUS"** The procedure with its complications has been explained to me in local vernacular language. I have fully understood that no special tests and extra expenditure in any form, merely for the purpose of thesis is being carried out. I am free to opt out the study any time without assigning any reason.

.....
Signature of the Witness

Name:

.....
Signature of the patient

Signature of Candidate

Signature of Supervisor

मरीज अनुमति फार्म

तिथि _____

मैं _____ पत्नी/पुत्र/पुत्री _____

निवासी _____

इस शोधकार्य "**TO EVALUATE THE DIAGNOSTIC EFFICACY OF CORNEAL EPITHELIAL THICKNESS USING SPECTRUM DOMAIN OPTICAL COHERENCE TOPOGRAPHY (SDOCT) IN KERATOCONUS**" में भाग लेने के लिए सहमत हूँ। मैं इस शोधकार्य में भाग लेने के लिए अपनी स्वेच्छा से तैयार हूँ। मैं पुष्टि करता/करती हूँ की यह स्वीकृति देने के लिए मुझे कोई आर्थिक प्रलोभन नहीं दिया गया और न ही दबाव डाला गया है। मुझे इस शोधकार्य का उद्देश्य स्पष्ट कर दिया गया है और मुझे यह विश्वास है की यह विज्ञान और मानवता के लाभ के लिए है। मुझे इस शोधकार्य में होने वाले जोखिम के बारे में समझा दिया गया है और मेरी समझ में यह जोखिम बहुत मामुली है।

मैं इस शोधकार्य में भाग लेने के सम्बन्ध में किसी भी समय अपनी अस्वीकृति व्यक्त कर सकता/सकती हूँ और मेरे अस्वीकृति व्यक्त करने का मेरे इलाज पर कोई प्रभाव नहीं पड़ेगा।

_____ _____

गवाह के हस्ताक्षर रोगी के हस्ताक्षर/अंगूठे का निशान

नाम: नाम:

_____

अन्वेषक के हस्ताक्षर

_____

विद्यार्थी के हस्ताक्षर

ਮਰੀਜ਼ ਰਜ਼ਾਮੰਦੀ ਫਾਰਮ

ਮਿਤੀ_____

ਮੈ_____ਪਤਨੀ/ਪੁੱਤਰ/ਪੁੱਤਰੀ_____

ਵਾਸੀ _____

"TO EVALUATE THE DIAGNOSTIC EFFICACY OF CORNEAL EPITHELIAL THICKNESS USING SPECTRUM DOMAIN OPTICAL COHERENCE TOPOGRAPHY (SDOCT) IN KERATOCONUS" ਤੇ ਚਲ ਰਹੀ ਖੋਜ ਵਿਚ ਹਿੱਸਾ ਲੈਣ ਲਈ ਰਜ਼ਾਮੰਦ ਹਾਂ। ਇਸ ਖੋਜ ਕੰਮ ਵਿਚ ਹਿੱਸਾ ਲੈਣ ਲਈ ਮੈ ਆਪਣੀ ਮਰਜ਼ੀ ਨਾਲ ਤਿਆਰ ਹਾਂ। ਮੈ ਇਹ ਦਸਣਾ ਚਾਹੁੰਦਾ ਹਾਂ/ ਚਾਹੁੰਦੀ ਹਾਂ ਕੇ ਇਹ ਰਜ਼ਾਮੰਦੀ ਦੇਣ ਵਾਸਤੇ ਮੈਨੂ ਕਿਸੇ ਵੀ ਤਰਾਂ ਦਾ ਲੋਭ-ਲਾਲਚ ਨਹੀ ਦਿੱਤਾ ਗਿਆ ਅਤੇ ਨਾ ਹੀ ਕੋਈ ਦਬਾ ਪਾਇਆ ਗਿਆ ਹੈ। ਮੈਨੂ ਇਸ ਖੋਜ ਦਾ ਮਨੋਰਥ ਸਮਝਾ ਦਿੱਤਾ ਗਿਆ ਹੈ ਅਤੇ ਮੈਨੂ ਇਹ ਭਰੋਸਾ ਦਵਾਇਆ ਗਿਆ ਹੈ ਕੇ ਇਹ ਖੋਜ ਵਿਗਿਆਨ ਅਤੇ ਮਾਨਵਤਾ ਦੀ ਭਲਾਈ ਲਈ ਹੈ। ਮੈਨੂ ਇਸ ਖੋਜ ਵਿਚ ਹੋਣ ਵਾਲੇ ਖਤਰੇ ਬਾਰੇ ਸਮਝਾ ਦਿੱਤਾ ਗਿਆ ਹੈ ਅਤੇ ਮੈਨੂ ਇਹ ਯਕੀਨ ਹੈ ਕੇ ਇਹ ਖਤਰਾ ਬਹੁਤ ਮਾਮੂਲੀ ਹੈ। ਮੈਨੂ ਇਸ ਖੋਜ ਕੰਮ ਵਿਚ ਹਿੱਸਾ ਲੈਣ ਦਾ ਢੰਗ – ਤਰੀਕਾ ਸਮਝਾ ਦਿੱਤਾ ਗਿਆ ਹੈ।

ਮੈ ਇਸ ਖੋਜ ਕੰਮ ਵਿਚ ਹਿੱਸਾ ਲੈਣ ਬਾਰੇ ਆਪਣੀ ਰਜ਼ਾਮੰਦੀ ਕਿਸੇ ਵੀ ਸਮੇ ਵਾਪਸ ਲੈ ਸਕਦਾ ਹਾਂ/ ਸਕਦੀ ਹਾਂ ਅਤੇ ਮੇਰੀ ਰਜ਼ਾਮੰਦੀ ਵਾਪਸ ਲੈਣ ਦਾ ਮੇਰੇ ਇਲਾਜ ਤੇ ਕੋਈ ਅਸਰ ਨਹੀ ਹੋਵੇਗਾ।

_____ _____

ਗਵਾਹ ਦੇ ਹਸਤਾਖਰ ਮਰੀਜ਼ ਦੇ ਹਸਤਾਖਰ

ਮਿਤੀ_____ ਮਿਤੀ_____

ਪਤਾ _____ ਪਤਾ _____

_____

ਨਿਰੀਖਕ ਦੇ ਹਸਤਾਖਰ

_____

ਸਿਖਿਆਰਥੀ ਦੇ ਹਸਤਾਖਰ